NORTH MILL CREEK WATERSHED BIOLOGICAL MONITORING PROJECT

QUALITY ASSURANCE PROJECT PLAN

LAKE COUNTY

STORMWATER MANAGEMENT COMMISSION

EFFECTIVE DATES: JULY 1, 2009-JULY 31, 2011

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APPROVALS:

Mike Prusia, LCSMC Project Manager — 8/4/2009 Date

Scott Tomkins, IL EPA Project Manager — 7/29/2009 Date

Mike Henebry, IL EPA Project Officer — 7/29/2009 Date

DISTRIBUTION LIST

The following individuals shall receive the current version of the Quality Assurance Project Plan and any updated version.

Patricia Werner, Lake County Stormwater Management Commission

Mike Prusila, Lake County Stormwater Management Commission

Scott Tomkins, Illinois Environmental Protection Agency

Mike Henebry, Illinois Environmental Protection Agency

Sub-contractor Project Managers

Sub-contractor Field Staff

Sub-contractor Laboratory Staff

PROJECT ORGANIZATION

The biological monitoring will be overseen and coordinated by the Lake County Stormwater Management Commission (SMC). Mike Prusila (SMC) will serve as the project manager and will provide oversight and management of the project. Patricia Werner (SMC) will provide project support. Field sampling and laboratory analysis will be performed by qualified subcontractors according to the terms of this QAPP and the Section 319 grant agreement under which the work is being completed. All subcontractors involved in the project will be responsible for ensuring that all aspects of their field collection and laboratory analysis and the maintenance of the laboratory's internal quality control/assurance conform with the standards set forth in this QAPP. The project manager is also responsible for the maintenance of the QAPP during the project period (July 1, 2009-July 31, 2011).

Advice and assistance with the design of the study has been and will continue to be provided by the Illinois Environmental Protection Agency and Illinois Department of Natural Resources. Sub-contractors engaged by SMC for sampling, data collection and analysis will follow the terms set forth in this QAPP. These terms will be included in all relevant subcontractor agreements. The North Mill Creek Project is staffed by the following positions:

Watershed Planner, Project Manager	Mike Prusila (Lake County SMC)
Planning Supervisor, Project Support	Patricia Werner (Lake County SMC)
Qualified subcontractor, Fish	TBD
Qualified subcontractor, Macroinvertebrates	TBD

Principle data users include:

Illinois Department of Natural Resources
Illinois Environmental Protection Agency
Lake County Forest Preserve District
Lake County Health Department
Lake County Planning and Development
Lake County Public Works
Lake County Stormwater Management Commission
North Mill Creek Watershed Planning Committee
U.S. Army Corps of Engineers
U.S. Environmental Protection Agency

PROBLEM DEFINITION & BACKGROUND

The Lake County SMC is developing a watershed-based management plan under a USEPA Section 319 grant for the North Mill Creek Watershed. The watershed is approximately 37 square miles in size with 30.9 miles of streams and is located in north central Lake County, Illinois and south central Kenosha County, Wisconsin. The stream network consists of North Mill Creek (called Dutch Gap Canal in Wisconsin), which

flows northeast from Red Wing Slough in Lake County into Kenosha County, Wisconsin, before curving back into Lake County where it generally flows from north to south through the watershed. One major tributary, Hastings Creek, is entirely within Lake County, Illinois. Hastings Creek drains Crooked and Hastings Lakes at the south end of the watershed and flows northeast to its confluence with North Mill Creek. The Lake County portion of the watershed is approximately 23 square miles in size and contains 23.8 stream miles. Hastings Creek and Rasmussen Lake, an on-line impoundment of North Mill Creek, are classified on the 2006 Illinois 303(d) list of impaired waters as non-supportive of aquatic life use (Rasmussen is impaired for aesthetic quality as well) (IL EPA, 2006). Nine other lakes in the watershed appear on the 2006 Illinois 303(d) list.

The North Mill Creek watershed is projected to experience significant development in the future. Between the years 2000 and 2030, population in the Lake County portion of the watershed is expected to increase by 271.4% and the number of households is expected to increase by 254.1% (NIPC, 2003). In light of these circumstances, Lake County SMC is developing a watershed-based management plan for the North Mill Creek Watershed. A major component of the watershed management plan is the watershed assessment, which reports the current conditions of the watershed and is used as the basis to make recommendations for the future.

PROJECT DESCRIPTION

While a separate study being done in conjunction with the watershed plan will gather data on chemical and physical parameters in lakes and streams in the watershed, this study will document current status of biological communities in rivers and streams at three points in the North Mill Creek Watershed in Lake County, Illinois. This will be achieved through the sampling and analysis of fish and macroinvertebrate communities and habitat assessment at three distinct locations on streams in the North Mill Creek watershed (see site location map, Appendix A). Fish communities will be sampled by collecting individuals using an electrofishing method employing a backpack unit and capture using dip nets. Macroinvertebrate communities will be sampled by collecting individuals using a jab sampling method employing dip and kick nets.

These three locations each represent a different set of watershed characteristics and are largely representative of other stream reaches immediately up- and downstream. The site on North Mill Creek near IL Route 173 captures a largely agricultural drainage area and is upstream of the only wastewater treatment plant (WTP) discharge in the watershed. The site on Hastings Creek near Miller Road is downstream of the Lindenhurst WTP. The site on North Mill Creek near Old Kelly Road is downstream of the Rasmussen Lake Dam and a short distance upstream of the confluence of North Mill Creek and Mill Creek, therefore capturing drainage from a large proportion of the watershed area. Additionally, these sites are also the locations chosen for the physical and chemical monitoring that will be performed in conjunction with this plan. U.S. Geological Survey (USGS) stream gauging stations are also located at the IL Route 173 station on North Mill Creek (USGS 05527900 North Mill Creek at Hickory Corners, IL), at the Miller Road station on Hastings Creek (USGS 05527905 Hastings Creek near Lindenhurst, IL) and at the Kelly Road station on North Mill Creek (USGS 05527910 North Mill Creek

near Millburn, IL). The USGS gauge is approximately 750 feet downstream of the Rasmussen Lake spillway. In 2008, the IL EPA sampled the macroinvertebrate community and the IDNR sampled the fish community at the approximate locations of the USGS stream gauges, and therefore at the proposed 2010 monitoring stations. See Appendix A for a site map showing the relative locations of all stream gauges and monitoring locations.

The data gathered from the macroinvertebrate samples will be used to calculate a macroinvertebrate index of biotic integrity (mIBI) to determine stream quality. Similarly, data gathered from the fish community samples will be used to calculate a fish index of biotic integrity (fIBI) to determine stream quality. Stream habitat data will be used to evaluate overall habitat quality and similarity among sampling locations. Sampling will take place in summer during periods of low stream flow and maximum temperatures.

PROJECT SCHEDULE
Request Bids/Proposals from qualified contractors: Spring 2010
Field Inspection of study area, define sample sites with contractor: June 2010
Perform all field sampling: July-August 2010 (weather dependent)
Analyze data, compute mIBI and fIBI, prepare reports: September 2010

DATA QUALITY OBJECTIVES AND CRITERIA

Biological assemblage data of this kind has previously been used by IL EPA to assess stream quality and has been employed in previous watershed plans compiled by Lake County SMC to make action recommendations. These methods minimize variability in assessment results, sources of variability are known and controlled, and will be directly comparable to other data of this type gathered by IL EPA, IDNR, and other agencies. Objectives are to achieve reasonably representative samples (determined in part by in-situ environmental conditions), perform reproducible studies in a cost-effective manner, and minimize bias. This data should be useful for comparison to biological communities of other streams in similar watersheds and for assessment of biological communities at the sampling locations over time to provide an indicator of overall watershed conditions following development and implementation of best management practices and programs recommended by the watershed plan. This will allow watershed planners to make recommendations concerning water quality in this watershed and will allow users of the watershed plan as well as other agencies (see “PROJECT ORGANIZATION” above) to compare these streams with those in other areas of the region and to track the composition of the communities in these streams over time.

DATA QUALITY CRITERIA

Data Quality Criterion	How criterion will be addressed
Precision	Not applicable to biological field collection
Bias	Bias will be minimized by having trained personnel perform the field data collection, adhering to the same sampling protocol each time and utilizing the same amount of effort for each location, per the IL EPA multiple-habitat method. Additionally, all available habitat types will be sampled.
Accuracy	Not applicable to biological field collection
Representativeness	Sampling will adhere to IL EPA recommended and/or approved protocols. All representative habitat types will be sampled at each site.
Comparability	Sampling will adhere to IL EPA recommended and/or approved protocols, standard analytical methods (mIBI & fIBI computation), and standardized taxonomy to ensure that data are comparable.
Completeness	Completeness will be achieved through two contract vehicles, one between SMC and IL EPA and a second between SMC and its subcontractor(s). These contracts will stipulate completion of the biological monitoring in conformance with the QAPP as a prerequisite for reimbursement. Any complications affecting the completeness of the data will be noted in field and final data reports
Sensitivity	To the greatest extent practical, sampling methods are designed to maximize the number of species and individuals sampled (captured) at a station. Because this project calls for generation of discrete data, the theoretical minimum measurement level for biological collection would be zero (0) individuals or species. However, it is possible that due to environmental conditions, equipment, and the sampling "ability" of project personnel, not all individuals within the sampling area will be captured. The SMC will contract with a consultant with demonstrated experience to meet sampling thoroughness and efficiency requirements in order to maximize capture and sensitivity.

SPECIAL TRAINING/CERTIFICATION

The qualified subcontractors selected to perform the sampling will possess college degrees in biology or other closely related fields and be experienced in biological field data collections. All field technicians assisting in data collection will be provided a copy of the QAPP prior to the field collection activities for review. The subcontractors will be responsible for training the field technicians and ensuring that they have adequate experience with biological field collection principles. Qualifications for subcontractors

will include the ability to identify all individuals to species. This may include engaging the services of a taxonomist to verify field vouchers, juveniles, or other individuals of undetermined species. All field collections and species identifications shall be performed by qualified subcontractors under supervision of the Project Manager.

Subcontractors performing the field sampling portions shall be required to obtain all necessary permits and approvals for the activity from the Illinois Department of Natural Resources prior to commencement of field work.

DOCUMENTATION AND RECORDS

The Lake County SMC shall retain this and any updated versions of the QAPP and will be responsible for distribution of the current version of the QAPP. The Project Manager will be responsible for appropriate updates to the QAPP, with approval from those parties listed on the Approval Sheet.

Field data generated will be retained by the Lake County SMC for at least 5 years. All appropriate field data sheets must be completed on-site at the time sampling occurs. Data sheets will include, at minimum: site identification, GPS location, date, time, and the name(s) of each investigator. Field data collection sheets used for this project can be found in Appendix B. All results, laboratory reports, and correspondence shall be retained for a minimum of 5 years. Voucher specimens shall be retained by the SMC for a minimum of 5 years.

All data from field collections and laboratory analysis shall be organized in a computerized spreadsheet designed for this project. Sampling and analysis results, including calculation of mIBI and fIBI for all sites, will be summarized in a final report to be completed by the qualified subcontractor(s), reviewed by SMC and reported to IL EPA.

SAMPLING PROCESS

SAMPLING STATIONS

The biological assessment of the North Mill Creek Watershed calls for sampling fish and macroinvertebrate communities at 3 locations within the watershed (North Mill Creek near IL Route 173, Hastings Creek near Miller Road, and North Mill Creek near Old Kelly Road). The sampling locations were chosen because they are representative of different stream and drainage area conditions within the watershed. North Mill Creek at IL Route 173 has been channelized in the past and receives runoff from a drainage area that contains a large proportion of agricultural land. Hastings Creek at Miller Road is also a channelized stream, but it receives treated effluent from the Lindenhurst WTP. North Mill Creek near Old Kelly Road is downstream of both of the former locations, as well as a dam and impoundment called Rasmussen Lake. This site captures runoff from a large portion of the entire watershed. Additionally, these 3 sites were chosen as locations for a water quality monitoring study being done in conjunction with this study and the development of the North Mill Creek Watershed-based Plan. Finally, there are USGS

stream gauges at each of these locations that continuously collect stream stage data. Given the additional background data that is or will be available at each of these sites, it is logical to sample biological assemblages at these locations rather than at other locations in the watershed. Latitude and longitude of sampling stations will be determined in the field using a GPS navigation device.

For fish sampling, the boundaries of the sampling reach will be determined based upon field conditions, but the reach should be representative of habitat available in the study area and contain as many habitat types as possible (i.e., pool, riffle, run). Sample reaches should be approximately 100-200 meters in length. Photos will be taken documenting the sampling reach.

For Macroinvertebrate sampling, the boundaries of the sampling reach will be determined based upon field conditions and will satisfy the criteria of the IL EPA multi-habitat method outlined in IL EPA's "Methods of Collecting Macroinvertebrates in Streams" (see Appendix C).

Sampling of both fish and macroinvertebrates will be performed once at each of the 3 stations during summer baseflow conditions.

SAMPLING METHODS

MACROINVERTEBRATE SAMPLING
Macroinvertebrate assemblages will be sampled using the Illinois EPA multi-habitat method (Appendix C). Given the drainage area, channel characteristics, and flow regime for all sampling sites, this method should be sufficient for all stations. The details of this sampling method are included in Appendix C.

MACROINVERTEBRATE FIELD SAMPLE PROCESSING
Between dips (as needed), the contents of the dip nets shall be transferred into a standard #30 (600 micron) sieve bucket or similar adequate sample container. After performing all dips and emptying the contents into the sample container, the contents of the sample container will be transferred to leak proof jars and preserved in 95% ethanol and labeled appropriately. The field sample processing procedures are those of IL EPA and are detailed in Appendix C.

Upon arrival at the laboratory, the chain of custody form shall be completed (Appendix B). Before the sample is processed, the taxonomist or lab technician should enter the site identification information on the laboratory bench sheet (see Appendix B).

The preserved sample should be thoroughly washed and soaked in water prior to sorting and any large organic material removed after being inspected for attached organisms. If the sample from a single site arrives in two or more containers, the contents should be combined at this time.

After washing, the sample should be spread evenly across a gridded pan marked with approximately 6 cm x 6 cm grids. The presence of large or obviously abundant organisms should be noted on the laboratory bench sheet, but they should not be removed from the pan.

A random numbers table shall be used to select 4 numbers corresponding to squares (grids) within the gridded pan. All material (organisms and debris) shall be removed from the four grid squares, and placed into a shallow pan. A small amount of water can be added to facilitate sorting. If there appear (through a cursory count or observation) to be 300 organisms ± 20% (cumulative of 4 grids), then subsampling is complete. Any organism that is lying over a line separating two grids is considered to be on the grid containing its head. In those instances where it may not be possible to determine the location of the head (worms for instance), the organism is considered to be in the grid containing most of its body.

If the density of organisms is high enough that many more than 300 organisms are contained in the 4 grids, the contents of the 4 grids shall be transferred to a second gridded pan. Grids shall be randomly selected for this second level of sorting as was done for the first, sorting grids one at a time until 300 organisms ± 20% are found. If picking through the entire next grid is likely to result in a subsample of greater than 360 organisms, then that grid may be subsampled in the same manner as before to decrease the likelihood of exceeding 360 organisms. That is, the contents of the last grid shall be spread into another gridded pan. Grids should be picked one at a time until the desired number is reached. The total number of grids for each subsorting level should be noted on the laboratory bench sheet.

FISH SAMPLING

Fish communities will be sampled by electrofishing, in accordance with the IDNR stream sampling guidelines as they pertain to backpack electrofishing (Appendix D). Gear specifications and safety procedures shall conform to those for backpack electrofishing outlined in the Minnesota Department of Natural Resources Electrofishing Guidelines (1999) (see Appendix E). Because each sampling station is wadeable during the sampling period (summer baseflow conditions), the fish community will be sampled using a backpack electroshocker. Each station is to be sampled starting at the downstream boundary and slowly and steadily maneuvering the electroshocker in all available habitats to the upstream boundary. Pulsed DC current usually yields the best results, however it is best to determine the best pulse rate and voltage in the field. Dip nets with a mesh not exceeding 1/4 in. shall be used to capture stunned fish. Captured fish are placed in a live well for later processing and live release. Blocking nets are set at the upstream and downstream station boundaries while electrofishing to prevent “escape” from the sample area. This can be effective in the capture of larger, more mobile species.

At least three experienced persons will staff each sampling event.

FISH FIELD SAMPLE PROCESSING

In accordance with the INDR stream sampling procedures (Appendix D), all fish under 6 inches (150 mm) in length will not be weighed, only length will be recorded. Fishes not easily identified and voucher specimens of each species present will be preserved in a 10% formalin solution, these will be labeled with sampling location, method, and date. Fish not retained as specimens will be returned alive to the stream. Fish requiring taxonomic identification in the laboratory should be classified using dichotomous ichthyological keys such as Becker's *Fishes of Wisconsin* (1983) or Smith's *Fishes of Illinois* (1979). Verification will be performed by a qualified biologist and the IDNR will be solicited for assistance as well.

HABITAT ASSESSMENT

The Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio Environmental Protection Agency will be used to assess habitat (Rankin, 1989). Methodology will follow that outlined in the guidance document produced by the Ohio EPA and included as Appendix F (Ohio EPA, 2006). This protocol has been used for similar studies in Illinois. QHEI field data entry sheets are included in Appendix B. Data collected on the field sheets will be transferred to a computerized spreadsheet or database.

SAMPLE HANDLING

All macroinvertebrate samples collected are labeled in the field and a data form is completed for each station. Data recorded on the form includes date, time, station information, sampling method, sampling duration, flow, depth, water temperature, and date and amount of the most recent precipitation event based on either the Lindenhurst or Antioch rain gauge. Water temperature and flow information for these sites should also be available from the Lake County Health Department sondes that will be deployed and collecting continuous data during the project period. Upon arrival at the laboratory, samples are logged into a dedicated logbook or electronic file. Final delivery of taxonomic data and taxa counts shall be in the form of a computerized database or spreadsheet sufficient to allow for calculation of mIBI. It shall contain, at minimum, taxonomic identification (per the "Analytical Methods" section below) and number of individuals of each identified taxa.

All fish samples collected for taxonomic identification in the laboratory are labeled in the field. A data form is completed for each station. Data recorded on the form includes date, time, station information, sampling method, sampling duration, flow, depth, number of species identified, number of species collected, species weights, and samples transported to the laboratory for analysis. Water temperature and flow information for these sites should also be available from the Lake County Health Department sondes that will be deployed and collecting continuous data during the project period. Upon arrival at the laboratory, samples are logged into a dedicated logbook or electronic file. Final delivery of taxonomic data and species counts shall be in the form of a computerized database or spreadsheet sufficient to allow for calculation of fIBI. It shall contain, at minimum, genus and species name (per the "Analytical Methods" section below) and number of individuals of each identified species.

ANALYTICAL METHODS

Raw data is compiled and entered into a computer database or spreadsheet. Sampling statistics such as numbers per station, taxa per station and others are computer-generated. For macroinvertebrate samples, the Macroinvertebrate Index of Biotic Integrity (mIBI) will be calculated. The mIBI is used by the IL EPA as an indicator of the quality of streams. The m-IBI will be calculated according to 7 metrics used by IL EPA. The IL EPA methodology for computation of the mIBI as well as the the tolerance coefficients and functional feeding group designations for each taxa are included in Appendix G.

For fish samples, Illinois Fish Index of Biotic Integrity (fIBI) will be calculated using the IL EPA standards for streams (Smogor, et al. 2000; IL EPA, 2005). Appendix H contains data for assigning values for each of the 10 fIBI metrics and an explanation of fIBI calculation procedure for this project.

Taxonomic identification and/or classification for macroinvertebrates shall be to the genus/species level wherever possible. The taxonomic identification shall be of sufficient detail to compute the mIBI according to IL EPA standards (Appendix G). Taxonomic identification of fishes shall be to the species level, in accordance with the IL EPA guidelines for computation of the fIBI (Appendix H).

QUALITY CONTROL

For macroinvertebrate and fish sampling, all field personnel are responsible for ensuring that proper sampling methods, sample preservation and sample custody to the laboratory are followed. Sample processing and sorting shall only be performed by personnel qualified and trained in these procedures. Taxonomic identifications of voucher specimens and those of undetermined species shall be performed by an IL EPA-approved taxonomist. A reference collection will be maintained by the SMC or the taxonomist.

INSTRUMENTS AND EQUIPMENT

FIELD EQUIPMENT

Rectangular-frame aquatic dip net (18” x 8”). 600-micron mesh (#30) bag for collection of macroinvertebrates.

Sieve bucket. U.S. Standard #30 mesh (600-micron) for collection of macroinvertebrates.

Sample containers. 500 mL or 1,000 mL wide-mouth bottles or similar for transporting macroinvertebrate and fish samples to laboratory. Macroinvertebrate and fish samples will be stored in separate containers.

Blocking nets. 6’ x 25’ seines with minimum ¼ inch mesh, or adequate width to block entire stream channel at upstream and downstream ends of sample reach.

Livewell or live-bucket. Plastic 15 gal. bin or similar adequate for temporary transport of captured fish and isolation from electric current.

Chest waders. Insulated chest waders in sizes to fit all field personnel.

Rubber gloves. In sizes to fit all field personnel.

Backpack electroshocker. Will meet specifications of Minnesota Department of Natural Resources Electrofishing Guidelines (1999), see Appendix E.

LABORATORY EQUIPMENT

Sub-contractors will be required to provide laboratory equipment suitable to identify macroinvertebrate and fish samples to species. This may include a standard dissecting microscope, compound microscope, or illuminated magnifier, gridded sorting pan, sorting pan, forceps, specimen vials (with caps and stoppers), sample labels, and sieve.

NON-DIRECT MEASUREMENTS

As part of the watershed plan development process, historical data and reports on the biological communities of the North Mill Creek watershed will be surveyed and incorporated or referenced in the plan where appropriate. However, this task is not proposed as a component of this QAPP and no analysis of historical data or data from other streams is intended as a part of this biological monitoring project.

DATA MANAGEMENT

All field data sheets will be photo-copied and supplied to the SMC Project Manager. The field data sheets will be transposed to electronic files by the subcontractors. These files will also be sent to the SMC Project Manager. The SMC Project Manager will verify that the electronic data files accurately reflect the field data sheets and that computed mIBI and fIBI are accurate and calculated according to IL EPA standards.

ASSESSMENT AND OVERSIGHT

Assessment will be the responsibility of the SMC Project Manager, although the subcontractor project manager will also play a critical role in ensuring that the QAPP is being adhered to during field collections and laboratory analysis. Any quality control or nonconformance issue affecting the final data will be reported to all data users.

REPORTS TO MANAGEMENT

The data gathering, laboratory analysis, and reporting for this project is expected to be completed within a four-month time frame. The subcontractor(s) shall summarize the

results of the biological monitoring and data analysis in a final report to the SMC. The SMC will review the report and submit it to IL EPA and IDNR for review.

VERIFICATION AND VALIDATION OF DATA

Data will be verified in the field according to the methods under "Sampling Methods" and "Quality Control" above. The SMC Project Manager will ensure that the data meet all the requirements of the QAPP. Data gathered in the field will also be verified through the collection of voucher specimens for identification in the laboratory. Generated mIBI and fIBI will be verified by the SMC Project Manager according to IL EPA protocol. Any data reliability issues, including departures from this QAPP, will reported by the subcontractors and by the SMC Project Manager. It will be the determination of the end user(s) if this data is suitable for their use.

VERIFICATION AND VALIDATION METHODS

The methods for verifying and validating data are discussed in the "Sampling Process", "Sampling Methods", "Sample Handling", "Analytical Methods", and "Quality Control" sections above. Raw data will be verified and validated in the field. For both fish and macroinvertebrates, samples collected in the field will be identified in the laboratory and classified. This will verify the data collected in the field.

RECONCILIATION WITH USER REQUIREMENTS

The sampling approach and methods and proposed analysis were selected in order to obtain results that satisfy the goals of the project, to collect data that will allow a reasonable characterization of the biological communities at three locations in the North Mill Creek watershed. Moreover, these methods and approaches were selected because they are consistent with the methods and approaches used by other agencies across the State of Illinois in data collection endeavors of this kind.

REFERENCES

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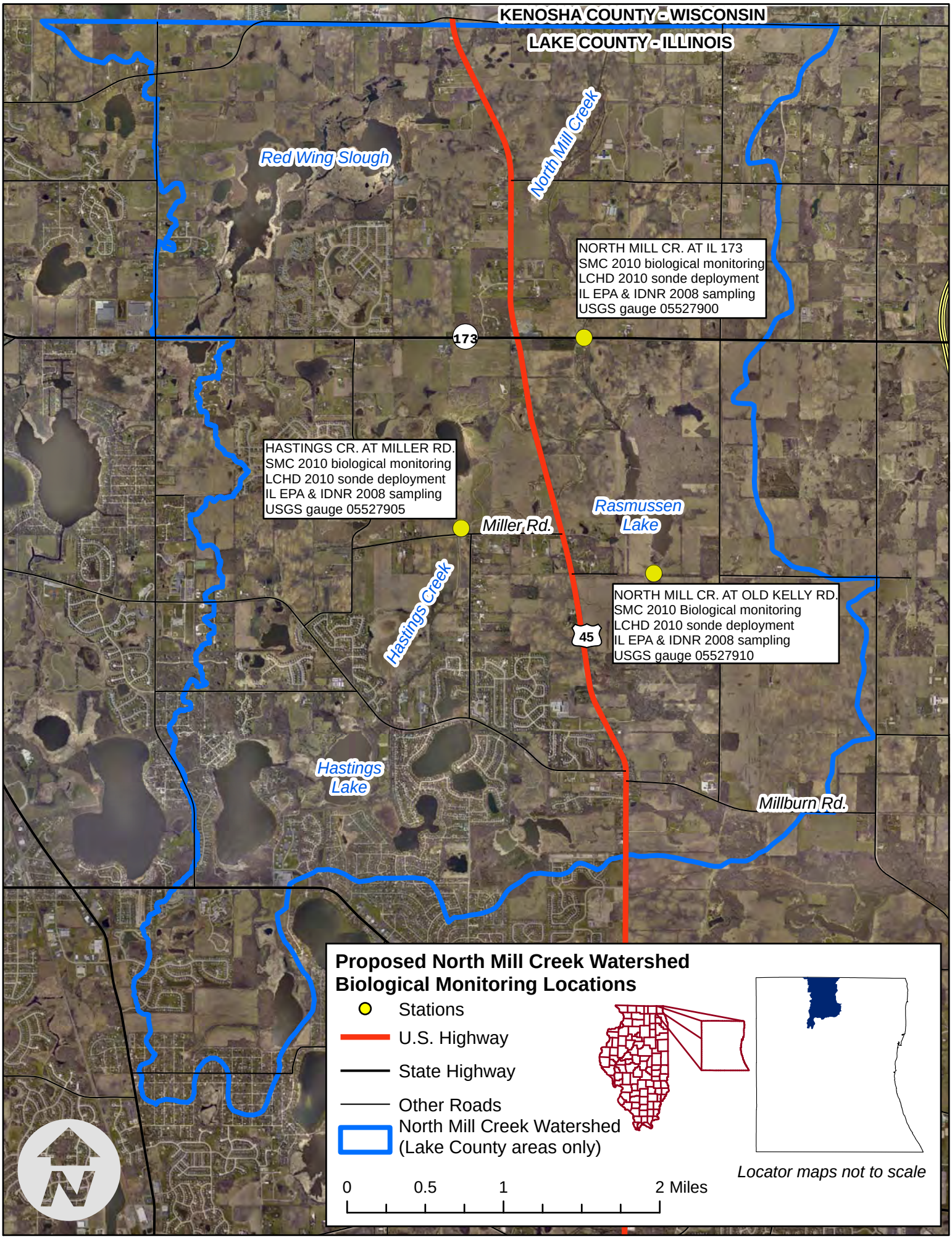
Smogor, R. and others, 2000, rev. 2006. Draft Manual for Calculating Index of Biotic Integrity Scores for Streams in Illinois. Springfield: Illinois Environmental Protection Agency, Bureau of Water.

APPENDIX A: Site Map



APPENDIX B: Data Collection Sheets & Forms

MACROINVERTEBRATE INVESTIGATION FIELD DATA SHEET Page _____ of _____

Stream:	IEPA Reach/Site ID:	Collection Date: _____ / _____ / 20_____
Location:	GPS Lat./Long.:	Time:
Sample Reach Length (ft.):	Slope (Determined from map):	ID Date: _____ / _____ / 20_____
Sample Reach Width (ft):	Depth (Thalweg, average three X-sections):	Sampling Effort (min):
Investigators:	Sampling Method/Equipment:	

HYDROLOGIC CONDITIONS:		**WEATHER CONDITIONS:**	
Q (cfs):	**Turbidity:** LOW - MODERATE - HIGH	**Air Temp (F):**	**Sky/Cloud Cover:**
Precip last 24 Hrs. (in):	**Water Color:** CLEAR - BROWN - GREEN - GRAY OTHER:	**Current Precip:**	**Wind:**
Hydrograph (choose 1): STABLE - RISING - FALLING	**Stage (choose 1):** INTERMITTENT - BASEFLOW ELEV. BASEFLOW - BANKFULL - OVERBANK		

NOTES: _____

BOTTOM ZONE HABITAT TYPES

Estimate % of streambed surface area belonging to each bottom zone habitat type. Do not include claypan or compacted soil areas in estimate. Total should equal 100%.		**Bottom Zone Dip Allocation**	Bottom Zone dips allocated by hatitat type
Fine Substrate (%):	streambed predominantly silt/mud to fine gravel, <8mm	To allocate Bottom Zone dips, multiply the % for each habitat type by the total # of Bottom Zone dips, based on the wetted width of the stream in the below table.	Fine Substrate:
Coarse Substrate (%):	streambed predominantly medium gravel to boulder >8mm		Coarse Substrate:
Plant Detritus (%):	streambed predominantly non-living organic debris, leaves, twigs	Total Bottom Zone Dips (from table):	Plant Detritus:
Vegetation (%):	streambed predominantly living plants, macrophytes, algae, submerged terrestrial spp.		Vegetation:

BANK ZONE HABITAT TYPES

Estimate length of space covered by each bank zone habitat type. For Submerged Terrestrial Vegetation and Submerged Tree Roots, estimate length of bank covered by each within the sample reach. For Brush-Debris jams, consider all brush-debirs jams as bank zone habitat, regardless of occurrence within the "bank zone" and provided that the jam occurs at a depth and velocity that allows for safe and sufficient dipnet sampling. Estimate length of longest axis of each brush-debris jam and sum for the total length of brush-debris jams.		**Bank Zone Dip Allocation** To allocate Bank Zone dips, divide the length of the habitat type by the total length of all Bank Sone Habitat Types. Multiply that ratio by the total # of Bank Zone dips, based on the wetted width of the stream in the below table. Do not allocate dips to any habitat type comprising less than 5% of the total length.	Bank Zone dips allocated by habitat type
			Submerged Terrestrial Vegetation:
			Submerged Tree Roots:
Submerged Terrestrial Vegetation (ft):	living terrestrial plants of which submerged portions provide cover or attachment sites		Brush-Debris Jams:
Submerged Tree Roots (ft):	living tree roots of which submerged portions provide cover or attachment sites	Total Bank Zone Dips (from table):	
Brush-Debris Jams (ft):	non-living, submerged woody material occurring above streambed surface and having microbial conditioning; excludes recent deadfall lacking microbial conditioning		
Total Length of all Bank Zone Habitat Types (ft):			

Allocate 20 dips based on sample reach width or mean wetted reach width (average of at least 3 measurements) and the following table:

Mean wetted width:	Assumed width of Bank Zone	Bank Zone Dips	Bottom Zone Dips
<10 ft.	25% of wetted width per bank	10	10
10-29 ft.	20% of wetted width per bank	8	12
30-59 ft.	15 % of wetted width per bank	6	14
60-99 ft.	10% of wetted width per bank	4	16
>100 ft.	5% of wetted width per bank	2	18

NORTH MILL CREEK WATERSHED BIOLOGICAL MONITORING PROJECT
CHAIN-OF-CUSTODY SHEET

Lake County Stormwater Management Commission
333 Peterson Road
Libertyville, IL 60048

IEPA Reach/ Site ID	Collector (Print)	Collection Date	Date Delivered to Laboratory	Reliquished By (print)	Received By (print)	Laboratory Log #
		____ / ____ / 20____	____ / ____ / 20____			
		____ / ____ / 20____	____ / ____ / 20____			
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		____ / ____ / 20____	____ / ____ / 20____			
		____ / ____ / 20____	____ / ____ / 20____			
		____ / ____ / 20____	____ / ____ / 20____			
		____ / ____ / 20____	____ / ____ / 20____			

NOTES:

MACROINVERTEBRATE LABORATORY BENCH SHEET

PAGE _____ OF _____

STREAM:	
IEPA REACH/SITE ID:	
COLLECTED BY:	COLLECTION DATE: _____ / _____ / 20____
TAXONOMIST:	ID DATE: _____ / _____ / 20____

# OF SORTING GRIDS PICKED:	LARGE OR ABUNDANT TAXA PRESENT:
NUMBER OF ORGANISMS:	
SORTING DATE: TIME (min):	
SORTED BY:	

ORGANISMS

Family	Genus/Species	Number	Life Stage	Taxonomist Initials

ORGANISMS

Family	Genus/Species	Number	Life Stage	Taxonomist Initials

FISH INVESTIGATION DATA SHEET Page _____ of _____

Stream:		IEPA Reach:	Collection Date: _____ / _____ / 20_____
Location:		GPS Lat./Long.:	Time:
Sample Reach Length (ft.):		Slope (Determined from map):	ID Date: _____ / _____ / 20_____
Sample Reach Width (ft):	Depth (Thalweg, average three cross-sections):	Water Temp. (F):	Sampling Effort (min):
Investigators:		Sampling Method/Equipment:	

HYDROLOGIC CONDITIONS:	
Q (cfs):	**Turbidity:** LOW - MODERATE - HIGH
Last Rainfall Date: **Last Rainfall (in.):**	**Water Color:** CLEAR - BROWN - GREEN - GRAY OTHER:
Hydrograph (choose 1): STABLE - RISING - FALLING	**Stage (choose 1):** INTERMITTENT - BASEFLOW ELEV. BASEFLOW - BANKFULL - OVERBANK

WEATHER CONDITIONS:	
Air Temp (F):	**Sky/Cloud Cover:**
Current Precip:	**Wind:**

NOTES: _____

	Common Name	Species Name	Plus Count	Batch Weight (g)	Length (mm)	Weight (g)	Anomalies/Notes*
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

*Note number of voucher specimens

Qualitative Habitat Evaluation Index and Use Assessment Field Sheet

QHEI Score: ____

Stream & Location: _____ RM: _ _ _._ Date: _ _/ _ _/ _ _

Scorers Full Name & Affiliation: _____

River Code: _ _ _- _ _ _- _ _ _ STORET #: _ _ _ _ _ _ Lat./ Long.: (NAD 83 - decimal °) _ _ . _ _ _ _ _ /8_ . _ _ _ _ Office verified location ☐

1] SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*Or 2 & average*)

BEST TYPES	POOL	RIFFLE	OTHER TYPES	POOL	RIFFLE
☐ ☐ BLDR /SLABS [10]	____	____	☐ ☐ HARDPAN [4]	____	____
☐ ☐ BOULDER [9]	____	____	☐ ☐ DETRITUS [3]	____	____
☐ ☐ COBBLE [8]	____	____	☐ ☐ MUCK [2]	____	____
☐ ☐ GRAVEL [7]	____	____	☐ ☐ SILT [2]	____	____
☐ ☐ SAND [6]	____	____	☐ ☐ ARTIFICIAL [0]	____	____
☐ ☐ BEDROCK [5]	____	____			

(Score natural substrates; ignore sludge from point-sources)

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☐ 3 or less [0]

ORIGIN		QUALITY	
☐ LIMESTONE [1]	SILT	☐ HEAVY [-2]	Substrate
☐ TILLS [1]		☐ MODERATE [-1]	
☐ WETLANDS [0]		☐ NORMAL [0]	
☐ HARDPAN [0]		☐ FREE [1]	
☐ SANDSTONE [0]	EMBEDDEDNESS	☐ EXTENSIVE [-2]	
☐ RIP/RAP [0]		☐ MODERATE [-1]	
☐ LACUSTURINE [0]		☐ NORMAL [0]	
☐ SHALE [-1]		☐ NONE [1]	
☐ COAL FINES [-2]			

Maximum 20

Comments

2] INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

____ UNDERCUT BANKS [1]	____ POOLS > 70cm [2]	____ OXBOWS, BACKWATERS [1]
____ OVERHANGING VEGETATION [1]	____ ROOTWADS [1]	____ AQUATIC MACROPHYTES [1]
____ SHALLOWS (IN SLOW WATER) [1]	____ BOULDERS [1]	____ LOGS OR WOODY DEBRIS [1]
____ ROOTMATS [1]		

AMOUNT

Check ONE (*Or 2 & average*)

☐ EXTENSIVE >75% [11]
☐ MODERATE 25-75% [7]
☐ SPARSE 5-<25% [3]
☐ NEARLY ABSENT <5% [1]

Cover Maximum 20

Comments

3] CHANNEL MORPHOLOGY

Check ONE in each category (*Or 2 & average*)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☐ NONE [6]	☐ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☐ MODERATE [2]
☐ LOW [2]	☐ FAIR [3]	☐ RECOVERING [3]	☐ LOW [1]
☐ NONE [1]	☐ POOR [1]	☐ RECENT OR NO RECOVERY [1]	

Channel Maximum 20

Comments

4] BANK EROSION AND RIPARIAN ZONE

Check **ONE** in each category for *EACH BANK* (*Or 2 per bank & average*)

River right looking downstream

L R EROSION	L R RIPARIAN WIDTH	L R FLOOD PLAIN QUALITY	L R
☐ ☐ NONE / LITTLE [3]	☐ ☐ WIDE > 50m [4]	☐ ☐ FOREST, SWAMP [3]	☐ ☐ CONSERVATION TILLAGE [1]
☐ ☐ MODERATE [2]	☐ ☐ MODERATE 10-50m [3]	☐ ☐ SHRUB OR OLD FIELD [2]	☐ ☐ URBAN OR INDUSTRIAL [0]
☐ ☐ HEAVY / SEVERE [1]	☐ ☐ NARROW 5-10m [2]	☐ ☐ RESIDENTIAL, PARK, NEW FIELD [1]	☐ ☐ MINING / CONSTRUCTION [0]
	☐ ☐ VERY NARROW < 5m [1]	☐ ☐ FENCED PASTURE [1]	
	☐ ☐ NONE [0]	☐ ☐ OPEN PASTURE, ROWCROP [0]	

Indicate predominant land use(s) past 100m riparian.

Riparian Maximum 10

Comments

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

MAXIMUM DEPTH

Check **ONE** (*ONLY!*)

☐ > 1m [6]
☐ 0.7-<1m [4]
☐ 0.4-<0.7m [2]
☐ 0.2-<0.4m [1]
☐ < 0.2m [0]

CHANNEL WIDTH

Check ONE (*Or 2 & average*)

☐ POOL WIDTH > RIFFLE WIDTH [2]
☐ POOL WIDTH = RIFFLE WIDTH [1]
☐ POOL WIDTH < RIFFLE WIDTH [0]

CURRENT VELOCITY

Check ALL that apply

☐ TORRENTIAL [-1]	☐ SLOW [1]
☐ VERY FAST [1]	☐ INTERSTITIAL [-1]
☐ FAST [1]	☐ INTERMITTENT [-2]
☐ MODERATE [1]	☐ EDDIES [1]

Indicate for reach - pools and riffles.

Recreation Potential
Primary Contact
Secondary Contact
(circle one and comment on back)

Pool / Current Maximum 12

Comments

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (*Or 2 & average*). ☐ NO RIFFLE [metric=0]

RIFFLE DEPTH	RUN DEPTH	RIFFLE / RUN SUBSTRATE	RIFFLE / RUN EMBEDDEDNESS
☐ BEST AREAS > 10cm [2]	☐ MAXIMUM > 50cm [2]	☐ STABLE (e.g., Cobble, Boulder) [2]	☐ NONE [2]
☐ BEST AREAS 5-10cm [1]	☐ MAXIMUM < 50cm [1]	☐ MOD. STABLE (e.g., Large Gravel) [1]	☐ LOW [1]
☐ BEST AREAS < 5cm [metric=0]		☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]	☐ MODERATE [0]
			☐ EXTENSIVE [-1]

Riffle / Run Maximum 8

Comments

6] GRADIENT (ft/mi)

DRAINAGE AREA (mi²)

☐ VERY LOW - LOW [2-4]
☐ MODERATE [6-10]
☐ HIGH - VERY HIGH [10-6]

%POOL: ____ %GLIDE: ____
%RUN: ____ %RIFFLE: ____

Gradient Maximum 10

A] SAMPLED REACH

Check ALL that apply

METHOD

- ☐ BOAT
- ☐ WADE
- ☐ L. LINE
- ☐ OTHER

STAGE

1st -sample pass-	2nd
☐ HIGH	☐
☐ UP	☐
☐ NORMAL	☐
☐ LOW	☐
☐ DRY	☐

DISTANCE

- ☐ 0.5 Km
- ☐ 0.2 Km
- ☐ 0.15 Km
- ☐ 0.12 Km
- ☐ OTHER

_____ meters

CLARITY

1st --sample pass--	2nd
☐ < 20 cm	☐
☐ 20-<40 cm	☐
☐ 40-70 cm	☐
☐ > 70 cm/ CTB	☐
☐ SECCHI DEPTH	☐

CANOPY

- ☐ > 85%- OPEN
- ☐ 55%-<85%
- ☐ 30%-<55%
- ☐ 10%-<30%
- ☐ <10%- CLOSED

1st pass _____ cm

2nd _____ cm

Comment RE: Reach consistency/ Is reach typical of steam?, *Recreation/* Observed - Inferred, *Other/* Sampling observations, Concerns, Access directions, etc.

B] AESTHETICS

- ☐ NUISANCE ALGAE
- ☐ INVASIVE MACROPHYTES
- ☐ EXCESS TURBIDITY
- ☐ DISCOLORATION
- ☐ FOAM / SCUM
- ☐ OIL SHEEN
- ☐ TRASH / LITTER
- ☐ NUISANCE ODOR
- ☐ SLUDGE DEPOSITS
- ☐ CSOs/SSOs/OUTFALLS

C] RECREATION

POOL: ☐ >100ft² ☐ >3ft (AREA DEPTH)

D] MAINTENANCE

Circle some & *COMMENT*

PUBLIC / PRIVATE / BOTH / NA
ACTIVE / HISTORIC / BOTH / NA
YOUNG-SUCCESSION-OLD
SPRAY / SNAG / REMOVED
MODIFIED / DIPPED OUT / NA
LEVEED / ONE SIDED
RELOCATED / CUTOFFS
MOVING-BEDLOAD-STABLE
ARMOURED / SLUMPS
ISLANDS / SCOURED
IMPOUNDED / DESICCATED
FLOOD CONTROL / DRAINAGE

E] ISSUES

WWTP / CSO / NPDES / INDUSTRY
HARDENED / URBAN / DIRT&GRIME
CONTAMINATED / LANDFILL
BMPs-CONSTRUCTION-SEDIMENT
LOGGING / IRRIGATION / COOLING
BANK / EROSION / SURFACE
FALSE BANK / MANURE / LAGOON
WASH H_20 / TILE / H_20 TABLE
ACID / MINE / QUARRY / FLOW
NATURAL / WETLAND / STAGNANT
PARK / GOLF / LAWN / HOME
ATMOSPHERE / DATA PAUCITY

F] MEASUREMENTS

- $\bar{x}$ width
- $\bar{x}$ depth
- max. depth
- $\bar{x}$ bankfull width
- bankfull $\bar{x}$ depth
- W/D ratio
- bankfull max. depth
- floodprone x^2 width
- entrench. ratio

Legacy Tree:

Stream Drawing:

[[Portions highlighted in green are the most recent revisions]]

Methods of Sampling Macroinvertebrates in Streams

A. Methods of sampling stream macroinvertebrates for determining biological integrity

A-1. General instructions

A-1.1 Sample macroinvertebrates during June 1 through October 15.

A-1.2 Select a sampling reach that:

- has instream and riparian habitat conditions typical of the entire assessment reach,
- has flow conditions that approximate typical summer base flow,
- has no highly influential tributary streams,
- contains at least one riffle/pool sequence or analog (i.e., run/bend meander or alternate point-bar sequence), if present, **AND**,

where the multi-habitat method is applicable (see below),

- is at least 300 feet long

A-1.3 Determine applicability of the multi-habitat method.

The multi-habitat method is applicable if :

- Conditions allow the sampler to collect macroinvertebrates (i.e., to take dips with a dipnet) in **all** bottom-zone and bank-zone habitat types that occur in the sampling reach. These habitat types are defined explicitly later in this document.

  AND

- Conditions allow the sampler to apply the 11-transect habitat-sampling method, as described in *"Wadable Streams Transect Approach"* in *Appendix 1, Section E: Stream Habitat and Discharge Monitoring,* in *Quality Assurance Project Plan* (Illinois EPA 1994) or to estimate with reasonable accuracy--via visual or tactile cues--the amount of each of several bottom-zone and bank-zone habitat types. If conditions (e.g., inaccessibility, water turbidity, or excessive water depths) prohibit the sampler from estimating with reasonable accuracy the composition of the bottom zone or bank zone throughout the entire sampling reach, then the multi-habitat method is not applicable. Typically, if more than half of the wetted stream channel cannot be seen, touched, or otherwise reliably characterized by the sampler, it is unlikely that reasonably accurate estimates of the bottom-zone and bank-zone habitat types are attainable; thus, the multi-habitat method is not applicable.

A-2. The multi-habitat method of sampling stream macroinvertebrates

The multi-habitat method of sampling stream macroinvertebrates (hereafter called the "multi-habitat method") provides information useful for determining the biological integrity of a stream, as reflected in selected attributes of the macroinvertebrate assemblage living in the stream. These biological attributes represent how macroinvertebrates respond to and integrate the chemical, physical, and biological effects of human-caused impacts (both negative and positive) on streams and their watersheds, e.g., point- or nonpoint-source impacts, stream-restoration efforts. The multi-habitat method allocates sampling effort based on the relative amounts of several predefined macroinvertebrate habitat types that occur in the sampling reach.

A-2.1 Identify several predefined macroinvertebrate-habitat types (listed below) based on conditions at the time of macroinvertebrate sampling. Determine the amount of each habitat type in the sampling reach:

Bottom-zone habitat types (four types):

- Fine substrate: streambed surface predominantly comprising silt/mud to fine gravel (i.e., particles < 8mm in diameter of intermediate dimension)

- Coarse substrate: streambed surface predominantly comprising medium gravel to boulder (i.e., particles $\geq$ 8 mm in diameter of intermediate dimension)

- Plant detritus: streambed surface predominantly comprising nonliving plant material (e.g., leaves, twigs)

- Vegetation: streambed surface predominantly comprising living plant material (e.g., aquatic macrophytes, filamentous algae, submerged terrestrial plants)

Bank-zone habitat types (three types):

- Submerged terrestrial vegetation: living, terrestrial plants (along stream banks) of which submerged portions provide cover or attachment sites for macroinvertebrates

- Submerged tree roots: living tree roots (along stream banks) of which submerged portions provide cover or attachment sites for macroinvertebrates.

- Brush-debris jams: non-living, submerged, woody material (e.g., branches, twigs, or smaller logs) that occurs above the streambed surface and that appears to have microbial conditioning. Excludes recent deadfall that lacks microbial conditioning.

A-2.1.1 For qualified, trained personnel having fewer than 2 years of experience in measuring and characterizing instream physical habitat (including stream-bottom composition) for purposes of natural-resource management, use the 11-transect habitat method to determine the amount of each habitat type:

- When applicable, measure and estimate habitat conditions by applying the appropriate parts of the 11-transect habitat method as described in *"Wadable Streams Transect Approach"* in *Appendix 1, Section E: Stream Habitat and Discharge Monitoring*, in *Quality Assurance Project Plan* (Illinois EPA, 1994). Specifically, use the 11-transect method to identify the "substrate" (see below) or "bottom type" (see below) at each of many points distributed regularly on the wetted stream bottom throughout the entire sampling reach. Also, per each of ten segments in the sampling reach, visually estimate the length of space occupied by each of the "instream cover type"s.

Substrates:

Name	Particle-Size Range
Silt/mud	< 0.062 mm
Sand	0.062 – 2 mm
Fine gravel	2 – 8 mm
Medium grave l	8 – 16 mm
Coarse gravel	16 – 64 mm
Small cobble	64 – 128 mm
Large cobble	128 – 256 mm
Boulder	256 – 4000 mm
Bedrock	> 4000 mm

Instream Cover Types:

Submerged terrestrial vegetation
Submerged tree roots
Brush-debris jam
Boulder (not embedded)
Undercut bank
Rock/clay ledge
Log
Aquatic vegetation
Other (please specify)

Bottom Types:

Claypan/Compacted soil
Plant detritus
Vegetation
Submerged log
Other (please specify)

- Based on the definition of each bottom-zone habitat type (see section A-2.1), translate each of the observations of "substrate" and "bottom type" into the appropriate bottom-zone habitat type and calculate and record the relative percentage of each bottom-zone habitat type in the sampling reach as:

Relative percentage of each bottom-zone habitat type =

$$\frac{\textit{Sum of the points (from all transects) at which the bottom-zone habitat type occurred}}{\textit{Sum of the points (from all transects) at which any of the four bottom-zone habitat types occurred}} \times 100$$

- When using the 11-transect habitat method, spatial coverage of each bank-zone habitat type is visually estimated within each of the ten stream segments delineated by the eleven transects. Estimate and record *Submerged terrestrial vegetation* and *Submerged tree roots* as the length of bank covered by each habitat type in the sampling reach. For estimating the amount of *Brush-debris jams* in the sampling reach, consider all brush-debris jams as bank-zone habitat, regardless of occurrence within the assumed bank zone (see Table 1)—provided that the brush-debris jam occurs at a depth and water velocity that allow safe and sufficient sampling of macroinvertebrates with a dipnet. Estimate the single longest dimension covered by each brush-debris jam and then sum these lengths to yield the total length of *Brush-debris jams*.

- If water turbidity or excessive depth prevents seeing the entire wetted stream channel throughout the sampling reach, the sampler may use tactile cues to obtain a reasonably accurate estimate of the amount

of each bank-zone habitat type. However, in most cases, if more than half of the wetted stream channel cannot be seen, touched, or otherwise reliably characterized by the sampler, it is unlikely that reasonably accurate estimates of these amounts are attainable; thus, the multi-habitat method is not applicable.

A-2.1.2 For qualified, trained personnel having 2 or more years of experience in measuring and characterizing instream physical habitat (including stream-bottom composition) for purposes of natural-resource management, use either of the following two approaches to determine the amount of each habitat type.

A-2.1.2.1 Visual-estimation approach

- Wade, walk the stream banks, or float (via boat or canoe) the sampling reach and visually estimate and record the percent surface area of the relevant portion of wetted stream bottom that consists of each of the four bottom-zone habitat types. The relevant portion is the portion of wetted stream bottom that consists of any of the four types of bottom-zone habitat. For example, because claypan is not considered as a bottom-zone habitat type for applying the multi-habitat method, the area of wetted stream bottom that consists of claypan should be ignored (in the denominator) when estimating the relative percentage of wetted stream bottom consisting of each of the four bottom-zone habitat types.

- Wade, walk the stream banks, or float (via boat or canoe) the sampling reach and visually estimate and record the length of space occupied by each of the three bank-zone habitat types. Estimate and record *Submerged terrestrial vegetation* and *Submerged tree roots* as the length of bank covered by each habitat type in the sampling reach. For estimating the amount of *Brush-debris jams* in the sampling reach, consider all brush-debris jams as bank-zone habitat, regardless of occurrence within the assumed bank zone (see Table 1)—provided that the brush-debris jam occurs at a depth and water velocity that allow safe and sufficient sampling of macroinvertebrates with a dipnet. Estimate the single longest dimension covered by each brush-debris jam and then sum these lengths to yield the total length of *Brush-debris jams*.

- If water turbidity or excessive depth prevents seeing the entire wetted stream channel throughout the sampling reach, the sampler may use tactile cues or knowledge of the channel morphology and streambed to obtain a reasonably accurate estimate of the amount of each bottom-zone and each bank-zone habitat type. However, in most cases, if more than half of the wetted stream channel cannot be seen, touched, or otherwise reliably characterized by the sampler, it is unlikely that reasonably accurate estimates of these amounts are attainable; thus, the multi-habitat method is not applicable

A-2.1.2.2 Point-transect approach

- When applicable, measure and estimate habitat conditions by applying the appropriate parts of the 11-transect habitat method as described in *"Wadable Streams Transect Approach"* in *Appendix 1, Section E: Stream Habitat and Discharge Monitoring*, in *Quality Assurance Project Plan* (Illinois EPA, 1994). Specifically, use the 11-transect method to identify the "substrate" (see A-2.1.1 above) or "bottom type" (see A-2.1.1 above) at each of many points distributed regularly on the wetted stream bottom throughout the entire sampling reach. Also, per each of ten segments in the sampling reach, visually estimate the length of space occupied by each of the "instream cover type"s (see A-2.1.1 above).

- Based on the definition of each bottom-zone habitat type (see A-2.1 above), translate each of the observations of "substrate" and "bottom type" into the appropriate bottom-zone habitat type and calculate and record the relative percentage of each bottom-zone habitat type in the sampling reach as:

  Relative percentage of each bottom-zone habitat type =

  $$\frac{\text{Sum of the points (from all transects) at which the bottom-zone habitat type occurred}}{\text{Sum of the points (from all transects) at which any of the four bottom-zone habitat types occurred}} \times 100$$

- When using the 11-transect habitat method, spatial coverage of each bank-zone habitat type is visually estimated within each of the ten stream segments delineated by the eleven transects. Estimate and record *Submerged terrestrial vegetation* and *Submerged tree roots* as the length of bank covered by each habitat type in the sampling reach. For estimating the amount of *Brush-debris jams* in the sampling reach, consider all brush-debris jams as bank-zone habitat, regardless of occurrence within the assumed bank zone (see Table 1)— provided that the brush-debris jam occurs at a depth and water velocity that allow safe and sufficient sampling of macroinvertebrates with a dipnet. Estimate the single longest dimension covered by each brush-debris jam and then sum these lengths to yield the total length of *Brush-debris jams*.

- If water turbidity or excessive depth prevents seeing the entire wetted stream channel throughout the sampling reach, the sampler may use tactile cues to obtain a reasonably accurate estimate of the amount of each bank-zone habitat type. However, in most cases, if more than half of the wetted stream channel cannot be seen, touched, or otherwise reliably characterized by the sampler, it is unlikely that reasonably accurate estimates of these amounts are attainable; thus, the multi-habitat method is not applicable.

A-2.2 Allocate effort for the multi-habitat method:

- Allocate 20 dips of effort to the bank zone and bottom zone. Based on mean wetted width of the sampling reach, determine the number of dips to perform in the each zone by consulting Table 1. If the 11-transect habitat method was not used, calculate mean wetted width based on measurement of the wetted width of at least three transects judged to reflect best the wetted width of the entire sampling reach.

- For sampling within the bank zone or within the bottom zone, further allocate dips based on the relative amounts of each corresponding habitat type (from sections A-2.1.1 and A-2.1.2). For each habitat type in each zone (bottom or bank), transform the relative amount into the number of dips to perform as follows:

  Number of dips to perform in a particular bottom-zone or bank-zone habitat type =

  $$\frac{\text{Percentage or length of habitat type}}{\text{Sum of percentages or lengths of all habitat types}} \times \text{Number of dips allocated (from Table 1)}$$

  For each zone, if the relative percentage of the habitat type is less than 5%, do not allocate dips to that type. When transforming relative amounts of habitat types into numbers of dips, round to the

nearest whole number. If rounding results in more than 20 dips for the total allocation across all habitat types, decrease the number of dips allocated to the most-abundant habitat type to limit the total to 20. Record the number of dips allocated to each bottom-zone habitat type and each bank-zone habitat type.

For example, for a stream having a mean wetted width of 37 feet, 14 dips are required from bottom-zone habitats and 6 dips are required from bank-zone habitats. Suppose the percent surface areas of the four bottom-zone habitat types are 48% *Fine substrate*, 32% *Coarse substrate*, 7% *Plant detritus*, and 13% *Vegetation* (please note that these percentages must sum to 100% because they are based only on the portion of stream bottom that consists of any of the four habitat types). Based on these amounts, the 14 bottom-zone dips should be allocated as:
7 dips in *Fine substrate* ([48 ÷ 100] x 14 = 6.72 ≅ 7), 4 dips in *Coarse substrate*, 1 dip in *Plant detritus*, and 2 dips in *Vegetation*.
Suppose the lengths of the three bank-zone habitat types are 5 ft. of *Submerged terrestrial vegetation*, 100 ft. of *Submerged tree roots*, and 50 ft. of *Brush-debris jams*. Based on these amounts, the 6 bank-zone dips should be allocated as: 4 dips in S*ubmerged tree roots* and 2 dips in *Brush-debris jams*. An insufficient relative amount (i.e., (5)/(5+100+50) = 3.2%, which is ≤ 5%) of *Submerged terrestrial vegetation* occurs to allocate even a single dip.

Table 1. Bank-zone and bottom-zone sampling-effort allocation.

Mean wetted width (to nearest foot)	Assumed width of bank-zone	Bank-zone dips	Bottom-zone dips
< 10 ft	**25% of wetted width per bank**	**10**	**10**
10-29 ft	**20% of wetted width per bank**	**8**	**12**
30-59 ft	**15% of wetted width per bank**	**6**	**14**
60-99 ft	**10% of wetted width per bank**	**4**	**16**
≥100 ft	**5% of wetted width per bank**	**2**	**18**

A-2.3 Perform the 20 dips.

A-2.3.1 General guidelines:

- One person performs all 20 dips.
- For each habitat type, take dips in the most-productive, stable areas. Most-productive areas generally occur where current velocity is relatively high. To minimize the potential for sampling bias attributable to uneven spatial distribution of macroinvertebrates throughout an entire stream reach, distribute multiple dips in (most-productive, stable areas of) each habitat type as evenly as possible throughout the sampling reach. In each of the two zones, bank versus bottom, if there is not enough sampling area to allow performing all of the dips allocated to a particular habitat type, then perform the remaining dips among the remaining habitat types in that zone. Allocate these remaining dips in proportions as close as possible to the orginal allocations.

A-2.3.2 Specific instructions:

- Use an 18x8-inch rectangular net with a Standard #30 (600-micron) mesh net.
- To perform a dip, place the net immediately downstream from the target area of the appropriate bottom-zone or bank-zone habitat type and dislodge macroinvertebrates by disturbing an 18x18-inch area. At higher water velocities, dislodged macroinvertebrates will be flushed directly into the stationary net. At lower velocities, capture dislodged macroinvertebrates by repeatedly sweeping the net directly above or adjacent to the 18x18-inch disturbed area. Always sweep in an upstream direction.
- When sampling fine-particle streambed substrates (e.g., silt/mud, sand), disturb the upper 1-inch of streambed in an 18x18-inch area by repeatedly bumping the leading edge of the net along the streambed surface. Complete the dip by capturing macroinvertebrates that are suspended over the sampling area by repeatedly sweeping upstream through the water column.
- Large pieces of wood or boulders may be sampled if they occupy the 18x18-inch sampling area **AND** if their dimensions would allow fitting these objects into the dipnet. When sampling these objects, wash, brush, or pick surface-clinging organisms into the dipnet and include them as part of the sample; do not retain the object in the sample.
- Between dips (as needed), combine the dipnet contents into a standard #30 (600-micron) sieve bucket (i.e., sample container). Before transferring dipnet contents to the sample container, excess debris or sediment may be removed only after first retaining all attached organisms. Removal of excess debris and sediment at this step greatly facilitates laboratory subsampling and sorting of the preserved sample. If necessary, transfer dipnet contents to a different sieve bucket or other suitable container and vigorously agitate, rinse, brush, or pick (as needed) to remove organisms from the debris; discard the debris only after ensuring that organisms have been removed. After "rinsing" and removing debris, transfer contents to the sample container.
- After performing all 20 dips and combining the contents into the sample container, transfer sample-container contents to an appropriate leak-proof jar(s) and preserve it with 95% ethanol. Label the container appropriately. If a sample contains large amounts of organic debris, check for sufficient preservation within five days (or sooner) of initial “fixing”; decant old fluid and add more 95% ethanol as needed to ensure sufficient preservation. Thereafter, periodically check the sample and re-preserve as needed.

B. Methods of Sampling Stream Macroinvertebrates for Determining Impacts of a Point-Source Discharge (i.e., Facility-Related Stream Survey)

[[pending]]

[[SOP for laboratory processing and subsampling of macroinvertebrate samples is needed here]]

IDNR-Fisheries Stream Sampling Guidelines

IDNR fisheries managers and others involved with the management of Illinois streams need accurate and consistent data on which to base their decisions. Guidelines for IDNR stream sampling help standardize the collection of stream-fish information. Standardized collection allows valid comparisons among sites by minimizing variability in sampling technique. Such comparisons are necessary for effective management and stewardship of stream resources throughout the state. Because Illinois streams differ greatly in physical and biological characteristics, statewide sampling guidelines must be flexible enough to accommodate this variability. These guidelines are intended to optimize data standardization while also accommodating the practical need to adjust sampling procedures to particular situations.

These guidelines were developed for professional, experienced fishery biologists, thoroughly acquainted with the operation, handling and maintenance of the sampling equipment; use of this equipment by inexperienced or uninitiated personnel could result in serious injury.

Background

The baseline and monitoring data collected by the Division of Fisheries provide sport fish population assessments which are important to stream fisheries management and protection (e.g., Sallee et al. 1991, Putman et al. 1995). Additionally, the sampling conducted by Fisheries biologists assists with delineating threatened and endangered species distributions (e.g., Burr et al. 1996) and fish community assessments. As part of the fish community assessments, fisheries data are used for characterizing stream health through the use of the Index of Biotic Integrity (IBI) (Karr 1981, Karr et al. 1986). Subsequently, the IBI was revised by Hite and Bertrand (1989) and adapted for use in Illinois through the Biological Stream Characterization (BSC) Work Group. The IBI was a major component of the BSC rating of streams into five integrity classes (A through E) (Illinois EPA 1996a) and was used in the Aquatic Life Use-Assessment of the IEPA 305(b) (Illinois EPA 1996b) report to the USEPA, which rates the water quality of Illinois streams. The BSC was also incorporated into the Illinois EPA Targeted Watershed Approach to stream protection and restoration (Illinois EPA 1997).

The IBI was revised again by Smogor (2000) using reference conditions as the basis for comparison to sample results. The results of this version of the IBI can be divided into five integrity classes following the guidelines of Illinois EPA (2003). Illinois DNR (2008) developed a biological stream rating system based on fish, mussel and aquatic macroinvertebrate sample data. This system can assign up to three designations for a stream segment; a diversity rating, integrity rating, and identification as a biologically significant stream.

Stream Sampling Guidelines address the three main objectives of the Division's stream fish sampling. These objectives are: 1) Fish community composition, 2) Sport fishery characterization and 3) Special (targeted) fish studies.

The goal of fish community sampling is to determine the identity and number of fish species present (species richness) and the relative number of individuals of each species (relative abundance) in a stream segment. Because length and weight of individual fish are routinely measured, estimates of species-specific population size and age structure can be obtained. Stream segment fish biomass estimates can also be calculated.

The second objective, Sport fishery characterization, is useful to the Fisheries Division in its strategic planning efforts and for informing the public on sport fishing opportunities in Illinois streams.

Special (targeted) fish studies are conducted to obtain detailed estimates of population size, population age and growth structure, or migration and movement patterns of particular target species. These studies are often conducted with specific management objectives in mind, such as fish stocking assessments, watershed management evaluations or fisheries response to habitat improvement efforts.

Section 1. Station Selection Criteria

Stations should be selected based upon the following criteria:

1. Sites which have been previously sampled (particularly during the 1981 - 1998 cooperative basin survey effort) should receive priority over sites for which no data have been collected.
2. If no historical fisheries data are available, then site selection should be based on general characteristics of stream habitat, location relative to tributaries or point source pollution, relative position within the watershed (e.g., headwaters, middle, mouth). Consideration should be given for ***both*** representative and unique habitats. For example, if a stream is predominantly channelized, then at least one station should be placed in a channelized reach, even if this is not considered the "best" section of the stream.
3. IEPA ambient water quality or macroinvertebrate sampling sites. Typically, IEPA ambient water quality sites have a substantial water chemistry data set and therefore can be supportive for fisheries data.

Section 2. Sampling station selection

A reconnaissance trip is strongly recommended to familiarize the lead biologist with each

potential sampling site. During the reconnaissance, the upstream and downstream limits of the sampling station may be determined and noted on the Stream Reconnaissance Form. The information on the reconnaissance forms should be sufficient to allow any IDNR fisheries biologist to lead the sampling. Although stream conditions can change from time of reconnaissance to time of sampling, this information can reduce confusion regarding where the sample is to be collected.

A reasonable attempt must be made to obtain landowner permission prior to sampling. The process of landowner contact can begin during reconnaissance, or by contacting the Natural Resources Conservation Service, in the county in which the stream segment to be sampled is located, to obtain the name, address and telephone number of the landowner in question. Landowners can then be contacted by phone and/or mail for permission to sample. Landowner information should be filed for subsequent sampling efforts.

Stream sampling locations should be chosen based on the physical characteristics (including stream width and depth) that will influence the amount of stream sampled. Stream segments to be sampled should be selected based upon habitat. Habitat diversity will also influence the length of stream sampled.

For non-channelized or old channelized (> 40 years) streams, *at least one* and preferably two to three pool/riffle sequences should be sampled. The number of pool/riffle sequences will depend upon the geological conditions, stream size and other factors, but this should be a minimum goal. No station should be less that 100 meters in length. If the hydraulic habitat is of a homogeneous nature (e.g., channelized), then a minimum of 15-21x normal base-flow width should be sampled. Normal base-flow is that volume of water that occupies the stream channel up to the vegetation (forbs, grasses, shrubs) line.

Setting the Station limits

Using the habitat criteria listed above, the upstream and downstream limits of the station are blocked with nets. When setting the nets, every effort should be made to avoid disturbing the area to be sampled. Crew members should not enter the area to be sampled until the nets have been secured and should remain downstream of the sampling area to minimize turbidity disturbance. The preferred locations for setting nets are constrictions or upstream limits of riffles. Consideration should be given to the effects of hydraulic modifications to the stream caused by a bridge, because bridges often present anomalous habitat conditions, they should generally be avoided. The nets should be long enough to block the entire stream width. Net height should be 6 ft and mesh should be 0.25 inch bar measure. Net stakes should be used to prevent the net from collapsing during the sampling. Usually, one stake for every 10 ft of stream width should be used in low flow conditions. More stakes may be required at higher stream discharges. The stakes are to be placed through the lead line and angled upstream. Metal bottom anchors (J-hooks) should be placed through the lead line to minimize fish escape. These may be supplemented with rocks. The float line should be pulled sufficiently taut to keep fish from jumping over the net, but not so tight that the lead line lifts off the stream bottom.

General Stream Conditions for Sampling
To maintain consistency with IDNR historical collections and optimize efficiency, sampling should be conducted during typical summer low-flow conditions. This is typically from early July to mid-September, although sampling could be conducted in June in far southern Illinois. Sampling should not be conducted at high flows without sufficient justification. Due to the lack of gauging stations on small-to-intermediate sized streams, it is difficult to develop standardized criteria for determining the range of flows that is acceptable for sampling, rather this is at the discretion of the lead biologist. Fish sampling and habitat data must be collected at the same flow levels, preferably on the same day or contiguous days.

Related to stream flow, water clarity (turbidity) is a critical component to sampling efficiency. Ambient turbidity will vary regionally in Illinois. For example, in south-central Illinois, the presence of clay-laden soils contributes to high turbidity levels even in low or no-flow conditions. By comparison, northern Illinois streams with rocky substrates, may have very low turbidity even in high flows. Turbidity should be characteristic for low-flow conditions. In eutrophic streams, phytoplankton blooms or floating aquatic macrophytes may also reduce visibility.

General Fish Sampling Procedures
Wadable sampling techniques should be used in streams with an average depth of 1.5 ft or less**.** Deep pools, up to 3.5 ft may be encountered in these streams, but they should not be common. When flow is present, wadable electrofishing is conducted from downstream to upstream. This is necessary to avoid creating plumes of silt in the area to be sampled. The increased turbidity limits visibility and reduces sampling efficiency. Only in ▪no-flow• or pooled conditions can sampling in an upstream to downstream direction be considered an option. Boat sampling and minnow seining may be conducted in either direction.

For all electrofishing, the amount of shocking time and length of stream sampled should be recorded. For minnow seining, the number and length of hauls, width of net used for each haul and average depth should be recorded.

When electrofishing, fish should not be kept in the dip nets and repeatedly subjected to the electrical field. Dip net handles must be made of non-conductive fiberglass or similar material and the net mesh should not be larger than 0.25 inch bar measure.

In community sampling, it is extremely important that netters attempt to collect all stunned fish. Every fish is important and could represent another species. To obtain this type of coverage, all representative habitats should be sampled and must be included in the sampling station.

A reasonable effort should be made to keep all fish alive. For most sampling, an oxygen supply is required and to prevent undo stress which may cause mortality, the use of a 0.5% solution (0.04 lbs per gallon) of non-iodized salt is used. For wadable streams an ▪R• oxygen bottle

provides a convenient source. During any electrofishing effort, if it appears that the number of fish is excessive and will result in stressed fish, then fish must either be redistributed to holding containers with adequate oxygen or sampling must be stopped and fish processed. If sampling is stopped, a block net should be placed at the location where sampling is interrupted. Fish should then be processed and released downstream of the station. A floating cage can also be used to hold fish while being processed. Upon completion of fish processing, sampling should then resume upstream of the temporary block net.

Section 3. Fish Sampling Techniques

Gear selection criteria

1) Boat electrofishing, supplemented with minnow seine hauls, is the method of choice when the habitats present within the station can be reasonably sampled with a boat (i.e., motor lower unit does not frequently contact the substrate and there is enough depth to operate the boat).
2) The electric seine (with block nets) should be used when the station is entirely wadeable (average depth is 1.5 ft or less) and narrow enough to block.
3) The backpack shocker (with block nets) is used when conditions won't permit use of boat electrofishing or electric seine (e.g., small headwater streams).

Boat electrofishing

A boat sampling crew should consist of a minimum of two (2) and up to five (5) people. Although only two people (one netter, one motor operator) are able to sample at a time, the additional people can collect water chemistry data and conduct minnow seining. When the electrofishing crew returns to the access site, fish can be processed immediately by two people and electrofishing can continue for the next run.

For small, non-wadable streams a 12'-14' boat is the preferred size as it allows movement over riffles and in confined areas. Dip net mesh size should be .125 to .25 inch. The motor operator and netter must communicate by using a variety of hand signals because generator noise usually precludes verbal communication. The netter and motor operator must watch for underwater obstructions, livestock fences or other potential hazards, and immediately alert one another to their presence. If anglers are encountered, the motor operator should either turn off the electricity to the electrodes or divert course to reduce disturbance.

If sampling is to be conducted upstream and downstream of the access point, then the downstream segment should be sampled first. This will reduce the likelihood of recapturing fish that are processed from the first sampling run. Because the effects of electrofishing differ among fish species, the crew should often check behind the boat for stunned fish. Frequent circling is recommended to assure adequate coverage of the station.

As at wadable sites, the actual length of a boat sampling station will vary with the stream size, habitat diversity and presence of impassable obstructions. Typically, a boat station will cover from 0.25 mile to one (1) mile. The electrofishing crew should sample all available habitats, including open water and midchannel areas, not just shoreline habitats. Electrofishing time must be accurately recorded. The length of stream sampled (combined length along both banks and midchannel) should be estimated (to within 10ft). This can be done on site (with tape measure or rangefinder) or may be measured on USGS topographic 7.5 minute quadrangle. Unlike wadeable sites, boat sampling stations are sampled for a given time (usually 15 or 30 min individual runs), rather than for a pre-determined distance.

When sampling in shallow water it may be necessary to get out of the boat to push the boat or retrieve fish. If this occurs, the power to the electrodes must be turned off before getting out of the boat.

Minnow Seine

The major emphasis of minnow seine sampling is to determine species occurrences. Minnow seine samples are usually collected to supplement boat electrofishing samples. A minnow seine crew should have a minimum of two (2) and optimally three (3) people. Minnow seining should not be the exclusive gear for non-headwater streams (>10 ft) wide. In headwater streams, conditions may be conducive for efficient minnow seining because stream width and depth allow sufficient 'sampling space' for this method. The length of seine used will vary with stream conditions, depth should be 6 ft and mesh should be 0.125 to 0.25 inch (bar measure). For pool or run conditions, an area relatively clear of obstructions should be selected. Sampling may be conducted either in an upstream or downstream direction. Number and length(s) of seine hauls should be recorded with the fish data. Circular sweeps allow sampling where debris or other obstructions restrict linear sampling.

Riffles or deep, fast runs can be sampled by placing the net across the riffle and having a crew member kick from upstream towards the net. If it is a large riffle, select an area up to 15 ft in width and place the net across that area. Then, one or more persons should walk upstream approximately 20 ft and begin kicking the substrate; moving downstream toward the net . When they arrive at the net, ▪kickers• should reach into the water, find the lead line and purse the net.

For all minnow seine sampling, it is very important that the lead line be kept on the bottom. If an impediment is encountered during a haul, attempts should be made to quickly dislodge or bypass the obstruction. When beaching the seine, keep the lead line pressed to the substrate and pull the seine towards shore. Quickly remove all fish from the seine and process (or preserve). The number and length(s) of seine hauls should be recorded with the fish data.

Electric Seine

Specifications for the electric seine may be found in Day et al. (2003). For electric seine sampling, the crew should consist of a minimum of five (5) persons with an optimum of six (6).

One (1) person is responsible for generator operation and assuring that fish are kept oxygenated. Three (3) members of the crew net fish and two (2) members operate the brails of the electric seine. Skilled brail operators may also opt to carry a dip net for maximum efficiency in confined areas. All persons will wear heavy duty (lineman) rubber gloves and either hip boots or chest waders (preferred). Prior to activating the seine, one of the brail operators must indicate verbally that the seine is going to be turned ■ON•. Similarly, when it is turned ■OFF• one of the operators must indicate that the seine is ■OFF•.

The pace of sampling should accommodate the netters so that when large numbers of fish are present, the operators should reduce forward progress until fish have been netted and placed in live wells. When appropriate, brush, logs, or shoreline cover should be sampled by having one or both of the brail operators wrap around the cover. The netters should keep pace with the brail operators as they surround the object, to collect stunned fish. Using their dip nets, the netters may need to push the electric seine into the brush or deeper pool to assure full coverage. After this process, the seine could briefly be turned off for the crew to regroup.

If the stream is wider than the electric seine the sampling crew should follow the thalweg, concentrating on instream cover and minimizing deep water fish escape routes. If depth is sufficient across the channel, a second pass may be needed to cover the "unsampled" side.

Riffles should be sampled by first carrying the electric seine upstream of the riffle and having the netters place the nets side by side at the downstream end of the riffle. The brail operators, with the seine ■ON•, should then kick the riffle to dislodge fish. Depending upon the length of the riffle, this could be done multiple times. If time and manpower allows, a minnow seine can be positioned below the riffle instead of or in addition to side by side dip nets.

Backpack Electrofisher

The backpack electrofishing crew will consist of a minimum of two (2) persons, with three (3) optimal. One person will operate the backpack, one person will net fish and carry a bucket to hold stunned fish. Block nets will be set as noted above. All persons will wear rubber gloves and either hip boots or chest waders. Electrofishing settings will be contingent upon water conditions including conductivity and depth, but settings should be sufficient to optimize collection, but to minimize harm to fish.

Backpack shocking is generally done in an upstream direction for reasons noted above. For optimal catch efficiency, the anode probe is thrust into cover (e.g., undercut bank, log jam) with the power "OFF", then drawn slowly back to the operator with the power "ON". This minimizes scaring fish and utilizes the galvanotaxic response of fish to DC current.

Section 4. Habitat and Methods Data

Procedures for completion of stream investigation forms and stream methods and habitat form are in the Operations Manual - FDM 6230 and FDM 6230.1, respectively.

Section 5. Fish Workup

1) Small fishes (e.g. minnows, darters and y-o-y sunfishes) and fishes not easily identified should be preserved in 10% formalin as quickly as possible for ease of identification and value as voucher specimens. Make sure preserved samples are clearly labeled with sampling location, method and date.

2) Weigh and measure length of all fishes greater than or equal to 6", measure length of smaller fishes

3) All reasonable effort should be made to return fish alive back to the stream.

4) Dead fish should be buried (preferred) or scattered throughout the surrounding area at least 50 ft from the stream in areas unlikely to cause inconvenience to stream users or landowners.

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ELECTROFISHING GUIDELINES

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Abstract--The purpose of these guidelines is to provide a structure that will enable electrofishing crews to safely and efficiently perform their work duties. Minnesota DNR employees have not had a serious injury during electrofishing operations and these guidelines were developed to ensure that there will not be any serious injuries in the future. The recent increase in the amount and use of electrofishing gear has created the need to develop statewide safety guidelines for acquisition, care, and operation of electrofishing gear. It also provides opportunities to work toward standardization of gear and techniques.

These guidelines are separated into 4 sections: 1) standards for acquisition of each type of gear; 2) personal protection equipment necessary for safe electrofishing; 3) training required; and 4) safe operational procedures.

- The following general statements summarize the attached safety guidelines:
- Any electrofishing gear not purchased from a commercial vendor **must** conform to published instructions and meet electrical codes and be safe (Novotny and Priegel 1971; Novotny and Priegel 1974);
- All electrofishing equipment must receive regular maintenance and inspection;
- DNR electrofishing participants must be certified in CPR, first aid, and electrofishing; and
- All electrofishing activities must be conducted in conformance with established safety procedures.

APPENDIX E: MN-DNR Electrofishing Guidelines

Table of Contents

Equipment Guidelines

I. Boom Electrofishing Boats

A. Boat

1. Boat equipment must comply with all Coast Guard and Minnesota DNR boat and water safety regulations.
2. The boat must be large enough and have sufficient flotation to provide for adequate freeboard when being operated.
3. The boat layout should be as simple as possible while providing adequate work space.
4. Boat shockers are routinely used at night. All electrofishing boats must be equipped with night navigation lights: A 20 point red/green light on the bow and a 360° white stern light.
5. The boat must be equipped with a hip high safety rail around three sides of the bow netting area. The material must be heavy enough and rigid enough to support a side thrust of at least 200 pounds (3/4" steel pipe, 1-1/2" heavy wall aluminum pipe or equivalent). ***Warning:*** Do not wrap the safety rail with electrical tape.
6. The work area and floor must be covered with non-skid material and sloped to allow drainage.

B. Generator

1. The generator should be a gasoline powered 115-230 volt AC or DC unit. Check with manufacturer to match the size of the generator to your application.
2. The generator must be muffled and/or housed so that the noise level of the unit is reduced to 85 dB (OSHA standard).
3. The generator exhaust must be piped away from operating personnel. The piping should be surrounded by rigid screen to reduce the chance of someone being burned by touching a hot exhaust pipe. The screening should be painted yellow to indicate it is a potential hazard area.
4. A grounding strap must be used to ground the generator to the hull (if aluminum boat) thereby preventing any accumulation of static electricity in the generator frame.
5. Electric generators designed for commercial or domestic use may have a neutral (internal) ground. Any internal ground ***must*** be disconnected from the generator. ***Warning:*** Do not use a generator with the neutral ground removed for any application other than electrofishing. Newer generators may have isolation transformers and can be used for both electrofishing and other applications.

C. Controls

1. All controls must be within easy reach of the operator.
2. All units must have an emergency shutdown switch which immediately cuts off the high voltage to the electrodes. This switch must be easily accessible to all personnel.
3. All electrofishing boats must contain at least two safety switches which break the high voltage circuit. All switches must be low voltage (not to exceed 24v). At least one safety switch should be a foot operated "dead man" switch operated from the front work deck. The "dead man" switch must be reachable by either dipper and require constant positive pressure to activate the high voltage circuit. The "dead man" switch must be attached to the low voltage control circuit by weatherproof devices. An operator "dead man" switch is mandatory on all new boom shockers and is strongly recommended for all existing units.

4. All power control circuits must be of low voltage (less than 24 volts).

D. Electrodes

The booms must be non-conductive (e.g. fiberglass). ***Warning:*** Plastic- or fiberglass-wrapped aluminum booms are not acceptable.

E. Wiring

1. All wires in the high voltage circuit must have an insulation rating higher than the maximum potential voltage of the unit. The wires must be of a standard type and of size appropriate for the maximum voltage and current of the circuit in which they are used, per National Electrical Code Association (NECA) standards. All wiring must conform to standard color coding for their application.
2. All electrically conductive equipment in the boat including gas cans (non-conductive safety gas cans are preferable), metal tool boxes, generator housing, etc., must be grounded to the boat.
3. All wires will be enclosed in raceways or liquid tight conduit except that a heavy duty rubber cord may be used when greater flexibility is required.
4. Splicing of wires is not permitted. All connections must be made in weatherproof (if switches) or watertight boxes (weatherproof and watertight per NECA standards). Wire connections must be made with appropriate size plastic wire nuts, per NECA standards.
5. Low voltage (24v maximum) light circuits are mandatory.
6. All branch circuits must be equipped with a fuse or circuit breaker enclosed in a weatherproof enclosure per NECA standards.
7. All wiring devices (connectors, receptacles, boxes, etc.) must be of appropriate size for the maximum voltage and current in the circuit in which they are used. Connectors and receptacles should be of corrosion resistant materials and should be of a locking style. Receptacles should have rainproof covers per NECA standards.

F. Color Coding of Hazards

1. Red color is used for fire extinguishers, danger areas (gas cans or other flammable liquids) and warning signs.
2. Orange color is used to indicate dangerous areas on exposed machinery -- pulleys, gears, etc.
3. Yellow color is used to indicate potentially dangerous areas -- hot pipes, sharp points or edges, etc.
4. Green color is used to identify all non-fire fighting safety gear -- first aid kits, etc.

G. Auxiliary Equipment

1. Dip nets must have nonconductive handles which are long enough to avoid hand contact with the water. Dip nets must not be used as electrodes. ***Warning:*** Plastic- or fiberglass-wrapped aluminum handles are not acceptable.
2. All wet cell batteries must be encased in a non-conductive, acid proof case which is properly vented.
3. A minimum of one (1A 10B C) fire extinguisher is required. The fire extinguisher must be mounted in a holder at a location which is convenient to the operator, yet outside areas of potential fire hazard.

4. All electrofishing boats must carry an instruction and operation manual which includes instructions for cable hook ups and operational safety guidelines. The manual should be contained in clear waterproof plastic and should be boat specific.
5. Each unit will be equipped with a log book containing daily check lists: date, time and extent of use; maintenance records; and a list of who operated the unit.

II. Generator Powered Stream Electrofishing Units

A. Generator powered electrofishing units must meet standards of commercially available gear.

B. Barge
1. The craft used to transport the generator must be large enough and buoyant enough to maintain adequate freeboard during operations.
2. The craft, towing strap, pack frame or push bar, must be made of non-conductive materials.
3. A pack frame when used as an aid to towing the craft, must be lightweight and have adjustable shoulder straps and hip belt.
4. It is useful to equip the craft with handles to assist in moving it through shallow riffles and over other obstructions.

C. Generator
1. The generator should be a gasoline powered 115-230 volt AC unit capable of producing DC output. Check with the manufacturer to match the size of generator with the electrofishing application.
2. The generator must be muffled or housed to limit the noise level to 85 dB for an 8 hour period per OSHA standards. The engine exhaust should be directed away from the participants. Any exhaust piping should be covered by rigid screening. The screening should be painted yellow.
3. The generator must have some mechanism to control the power output, a throttle to control rpms, a rheostat or pulsator, step up/down transformers, etc.

D. Controls
1. All high voltage circuits must be controlled by a low voltage relay switch system. An emergency shut down switch that shuts off high voltage to all electrodes must be in place. The relay should be attached to the generator by a non-rigid connection so that the vibration of the generator will not cause damage to the relay switch unit. A generator kill switch is also recommended.
2. All portable hand-held electrodes must be equipped with a low voltage, electrically insulated waterproof switch. All switches in hand-held electrodes must be wired in electrical series.
3. The high voltage circuit should be equipped with an ammeter to indicate the operating amperage.

E. Electrodes
1. Anode must be electrically insulated from the rest of the system.
2. Handles of hand-held electrodes must be made of non-conductive material. ***Warning:*** Plastic- or fiberglass-wrapped aluminum handles are not acceptable.
3. Hand-held electrodes shall not be used as dip nets.

4. Electrodes should be connected to the relay-control box by flexible, heavy rubber electrical cord and multi-strand wire of a sufficient gauge and insulation for the maximum potential voltage and current in the high voltage circuit. Any wiring devices used in connecting hand-held electrodes to the heavy rubber cord must be weatherproof and be of proper size for the maximum potential current in the high voltage circuit. It is recommended that the cord be contained in a spring-loaded reel which is attached to the barge. For stream electrofishing, electrodes must have off/on switches or pressure switches.

F. Wiring
1. Wires must conform to NECA specifications for the maximum voltage and current in the circuit in which they are used.
2. No splicing of wires is permitted. All connections must be secured with proper sized (per NECA standards) plastic wire nuts in a weather tight (if a switch) or watertight box (weatherproof and watertight per NECA standards).
3. All electrical devices used (receptacles, connectors, etc.) must conform to NECA specifications for the maximum potential voltage and current in the circuit in which they are employed. Devices must be made of corrosion resistant materials and be of a locking style. Switches must have weatherproof covers and receptacles must have rainproof covers, per NECA standards.
4. The relay-control box must be in a weatherproof junction box with weatherproof cover, per NECA standards.

G. Color Coding of Hazards
1. Red color is used for fire extinguishers, gas cans and warning signs.
2. Orange color is used to indicate dangerous areas on exposed machinery.
3. Yellow color is used to indicate potentially dangerous areas -- hot pipes, sharp points or edges, etc.

H. Auxiliary Equipment
1. Dip nets must have handles that are non-conductive. ***Warning:*** Plastic- or fiberglass-wrapped aluminum handles are not acceptable. The handles must be strong enough and rigid enough to assist with a person's balance.
2. A unit specific operation manual, if available must be present at all operations.

III. <u>Back Pack Electrofishing Units</u>

A. Back pack electrofishing units must meet standards of commercially available gear.

B. Power Source
1. Battery
The battery must be of a sealed unit, gel type design.
2. Generator
Commercially available units must have a tilt kill switch.

C. Controls
1 The unit should be equipped with an ammeter to indicate the amperage in the high voltage circuit when the unit is in operation.

2 The unit must be equipped with an indicator light which is activated when the high voltage circuit is activated.
3 Each electrode must be equipped with a low voltage, electrically insulated waterproof switch. All electrode switches must be wired in electrical series.
4 The control box must contain a master switch which will shut off all power from the transformer unit.

D. Electrodes
1. Electrode handles must be non-conductive e.g. fiberglass. ***Warning:*** Plastic- or fiberglass-wrapped aluminum handles are not acceptable
2. Electrodes must be connected to the relay-transformer unit with heavy rubber electric cord of a size large enough to handle the maximum potential voltage and current of the unit, per NECA standards. Any electrical devices used in connecting the hand-held electrodes with the transformer/control unit should be made of corrosion resistant materials and be of a waterproof locking style.
3. Hand-held electrodes shall not be used as dip nets.

E. Wiring
The wires used must be of proper size and have sufficient insulation for the maximum potential voltage and current of the unit.

F. Pack Frame
1. The frame must be lightweight and adjustable, with shoulder straps and hip belt each equipped with a quick release mechanism.
2. The frame must be constructed of non-conductive material.

G. Auxiliary Equipment
1. Dip nets must have handles that are non-conductive. ***Warning:*** Plastic- or fiberglass-wrapped aluminum handles are not acceptable. The handles must be strong enough and rigid enough to assist with a person's balance.
2. A Unit specific operation manual must be present at all operations.

Personal Protection Equipment

Electrofishing can be dangerous. At least two people have died and over 400 people have been injured during electrofishing operations in the United States in the last 20 years.

There are four serious safety concerns about electrofishing activities: 1) drowning; 2) electrocution; 3) hearing loss; and 4) personal injury. The use of proper personal protective gear can significantly reduce chances of injury.

The following personal protection devices will be used in all electrofishing operations:

A. Gloves and boots
1. Gloves - must be worn by all participants during all electrofishing operations. All gloves must be rubber or PVC, dry inside and free of leaks. Extra gloves should be available. Neoprene gloves are not approved
2. Boots - All personnel involved in all electrofishing operations will wear hip boots or chest high waders. Neoprene boots are approved.

B. Ear protection - Ear plugs or ear muffs will be made available to all participants during electrofishing operations where a gas powered generator is employed. In some operations where the generator is very loud, the use of voice-activated protective headsets may be useful to aid in communication between participants.

C. Personal Flotation Device - An approved PFD shall be worn by all participants during all boat electrofishing operations. The use of approved PFDs in stream shocking operations will be at the discretion of the crew leader. Approved PFDs will be made available to any participants who wish to use them during any stream electrofishing operation.

D. Eye protection - Under most daylight conditions, the wearing of polarized lens glasses is recommended to increase in-water visibility and improve the efficiency of fish capture.

E. First aid kit - A 10 unit or larger first aid kit will be available during all electrofishing operations.

F. Nomex fire fighting shirts will be worn while carrying a gas powered back-pack generator. These shirts are available from Field Services.

Training

All personnel who use or who are expected to use electrofishing gear will receive certification in cardio-pulmonary resuscitation (CPR), basic first aid, and proper, safe electrofishing techniques. All full time fisheries personnel must complete the Minnesota DNR or U.S. Fish and Wildlife Service electrofishing training once to become a certified electrofishing operator.

Operational Procedures

I. Inspections and Maintenance

The Area Fisheries Supervisor/Senior Research Biologist/Unit Leader is responsible for insuring that all safety checks are completed and for designating a (one) crew leader. The designated crew leader is responsible for all electrofishing activities for the day assigned.

Annual inspection - Every electrofishing unit must be inspected by a certified electrofishing operator at least once a year, before spring operations begin. The inspector will complete the inspection checklist. Copies of the checklist will be maintained in the Area Fisheries Station files and in the electrofishing unit log (see Appendix 1-3).

Daily inspection - The crew leader is responsible for the safe operating condition of the equipment. The inspection must be done by a certified electrofishing operator before the operation has begun. An inspection report can (optional) be filled out and kept in the electrofishing log (see Appendix 4-6).

Maintenance - All mechanical components must be maintained according to the manufacturer's instructions.

Repairs - All repairs, updates, modifications, etc. must conform to OSHA and NECA standards. It is strongly recommended that commercially purchased electrical components be repaired or altered by the manufacturer or his designated repair vendor.

II. Operation Safety Guidelines

The Area Fisheries Supervisor/Senior Research Biologist/Unit Leader is responsible for insuring that all safety guidelines are followed and for designating a (one) crew leader. The designated crew leader is responsible for all electrofishing activities for the day assigned.

A. All electrofishing operations require at least two Fisheries personnel, one of which is the crew leader.
   1. The crew leader must be a certified electrofishing operator;
   2. Two people on the crew must be certified in CPR and first-aid.

B. Electrofishing must not be attempted during periods of heavy precipitation and/or during electrical storms.

C. Personal flotation devices must be worn at all times during boat electrofishing operations.

D. The crew leader shall brief all participants on safety procedure before the operation is started.

E. Uniform hand signals (see Appendix 7) for communication will be used by all participants.

F. Excess gear should be kept to a minimum. Work areas should be kept clear and good housekeeping habits followed.

G. The generator may be refueled only when the unit is off and cool.

H. Electrodes should not be touched at any time during the operation.

I. No one should reach into the water at any time during the operation. If something falls into the water, turn off the output power and then retrieve the object.

J. No one should become overly fatigued - plan regular rest stops.

III. Use of Volunteers and Interns

A. Volunteers (Refer to Appendix 8) - May be used to assist and to observe electrofishing operations. They can not be used in place of the "standard" base crew. The crew leader must have the volunteer(s) complete the "DNR Volunteer Agreement", and conform to the "Minnesota DNR Volunteer Guidelines." The crew leader is responsible for the volunteers.

B. Interns - Can be integrated into work crews after being certified in CPR and First Aid, and having been instructed by certified electrofishing personnel. Interns can not serve as a crew leader. The crew leader is responsible for the interns.

References

Novotny, D. W., and G. R. Priegel. 1971. A guideline for portable direct current electrofishing systems. Wisconsin Department of Natural Resources, Technical Bulletin 51, Madison.

Novotny, D. W., and G. R. Priegel. 1974. Electrofishing boats. Improved designs and operational guidelines to increase the effectiveness of boom shockers. Wisconsin Department of Natural Resources, Technical Bulletin 73, Madison.

Appendix 1. Annual electrofisher boat safety inspection checklist.

Boat Inv. #_____ Registration #_____

Boat Model/make_____ Length_____

Discipline/unit_____ Location_____

Inspection Date_____ Inspected by_____

Log Book: Up to date Yes___ No___

Inventory Complete Yes___ No___

BOAT

___ 1. Hull integrity
___ 2. Painted areas intact - correct colors
___ 3. Safety railing intact and sturdy
___ 4. Non-skid footing
___ 5. Wiring okay - connections secure, etc.
___ 6. Adequate connectors and adequate interlocking (integral with hull)
___ 7. All metal equipment in boat electrically bonded/connected to hull (check with volt/ohm meter)
___ 8. Lighting properly protected - navigational lights working
___ 9. Batteries properly enclosed and vented
___ 10. Regulation fuel containers
___ 11. Boat clean - equipment neatly stored
___ 12. Decals, numbers, names - intact, legible
___ 13. Oars or paddles present and in good condition
___ 14. Anchor and bailer present

BOAT MOTOR

___ 1. Servicing up to date
___ 2. Components working properly
___ 3. Auxiliary motor working (where applicable)
___ 4. Proper venting of exhaust
___ 5. No gasoline leaks
___ 6. Bilge blower operating (where applicable)

GENERATOR

___ 1. Servicing up to date
___ 2. Muffler okay - properly piped, screened and color coded
___ 3. Internal ground removed (check with volt/ohm meter)
___ 4. Emergency shut off working
___ 5. Output voltage checked

ELECTROFISHER

___ 1. Controls and gauges operational
___ 2. Booms made of non-conductive material
___ 3. Adequate mechanical protection of wiring
___ 4. Adequate connectors and interlocking
___ 5. Operator's safety switch working
___ 6. "KILL SWITCH" working
___ 7. "Deadman" switches working
___ 8. Wiring to electrodes in good condition
___ 9. Electrodes in good condition

ANCILLARY EQUIPMENT

___ 1. Annual inspection completed
___ 2. Fire extinguisher present - fully charged - correct type
___ 3. First aid kit present - fully replenished
___ 4. Inspect protective hand and head gear
___ 5. Safety gas containers - regulation style
___ 6. Dip net handles made of non-conductive material

Appendix 2. Annual stream electrofisher safety inspection checklist.

Unit Inv. #_____

Make_____ Model_____

Discipline_____ Location_____

Inspection Date_____ Inspected by_____

Log Book: Up to date Yes___ No___

Manual Present: Yes___ No___

Inventory Complete Yes___ No___

CRAFT

___ 1. Hull integrity
___ 2. All metal equipment grounded to craft
___ 3. Towing strap/pack frame/push bar in good condition

GENERATOR/ALTERNATOR

___ 1. Electrical connections secure and protected
___ 2. Mountings secure
___ 3. Exhaust directed away from operator - properly screened and color coded
___ 4. Generator should be grounded to the frame
___ 5. All metal components grounded to generator frame
___ 6. Engine serviced to date/oil change
___ 7. Internal ground removed
___ 8. Check output voltage

ELECTROFISHER

___ 1. Controls and gauges operational
___ 2. Adequate mechanical protection of wiring
___ 3. Adequate connectors and interlocking
___ 4. Operator's safety switch working
___ 5. "KILL SWITCH" working
___ 6. Anode switches working
___ 7. Wiring to anodes in good condition
___ 8. Anodes in good condition - attached to handle securely
___ 9. Anode handles of non-conductive material
___ 10. Cathode plate clean - connection secure

ANCILLARY EQUIPMENT

___ 1. Annual inspection completed
___ 2. Fire extinguisher present - fully charged - correct type
___ 3. First aid kit present - fully replenished
___ 4. Inspect protective hand and head gear
___ 5. Safety gas containers - regulation style
___ 6. Dip net handles made of non-conductive material

Appendix 3. Annual back pack electrofisher safety inspection checklist.

Unit Inv. #_____

Make_____ Model_____

Owner/Operator_____ Location_____

Inspection Date_____ Inspected by_____

Log Book: Up to date Yes___ No__ Manual Present: Yes___ No___

ELECTROFISHER

___ 1. Controls and gauges operational
___ 2. Adequate protection of wiring
___ 3. Adequate connectors and interlocking
___ 4. "KILL SWITCH" working
___ 5. Switches on electrodes working
___ 6. Wiring in good condition
___ 7. Electrodes in good condition, and clean
___ 8. Electrode handles of non-conductive material
___ 9. Cathode clean and secured tightly
___ 10. Back pack frame in good condition and non-conductive
___ 11. Quick release mechanism of back pack frame working
___ 12. High voltage light working

GENERATOR/ALTERNATOR (where applicable)

___ 1. Electrical connections secure and protected
___ 2. Mountings secure
___ 3. Exhaust directed away from operator - if applicable
___ 4. The frame is non-conductive
___ 5. Engine serviced to date/oil changed - if applicable
___ 6. Engine clean and no oil or gas leaks - if applicable
___ 7. Check output voltage

ANCILLARY EQUIPMENT

___ 1. Annual inspection completed
___ 2. Inspect protective hand gear
___ 3. Dip net handles made of non-conductive material
___ 4. First aid kit - fully replenished, and carried by a different crew member in a backpack
___ 5. Safety gas containers - regulation style -
___ 6. Fire extinguisher must be present when using a gas powered generator which is the correct type and fully charged, and carried by a different crew member.

Appendix 4. Daily electrofisher boat field check sheet.

Boat Inv. #_____ Date_____

Time_____ Location_____

Crew Leader_____

Crew Members_____

Log Book: Up to date Yes___ No___ Manual Present: Yes___ No___

BOAT

___ 1. Hull integrity
___ 2. Safety railings intact and sturdy
___ 3. Decks clean, free of excess water/bilges dry
___ 4. Adequate mechanical protection of wiring
___ 5. Adequate connectors and interlocking (integral with hull)
___ 6. All metal equipment in boat electrically bonded to hull (checked with volt/ohm meter)
___ 7. Batteries fully charged - properly enclosed and vented
___ 8. Communication gear working (where applicable)
___ 9. Boat clean, equipment neatly stored
___ 10. Auxiliary motor present and working (where applicable)
___ 11. Oars/paddles present
___ 12. Anchors/balers present
___ 13. Night navigation lights working

GENERATOR

___ 1. Electrical connections secure
___ 2. Mounting secure
___ 3. Frame grounded

ELECTROFISHER

___ 1. Controls and gauges operational
___ 2. Adequate mechanical protection of wiring
___ 3. Adequate connectors and interlocking
___ 4. High voltage flashing light working
___ 5. All safety switches working
___ 6. "KILL SWITCH" working
___ 7. Operators safety switch working

ANCILLARY EQUIPMENT

___ 1. Fire extinguisher fully charged
___ 2. First aid kit present and full
___ 3. Enough personal safety gear present - gloves, boots, ear protection, PFDs reflective clothing

Appendix 5. Daily stream electrofisher boat field check sheet.

Unit Inv. #_____ Date_____

Time_____ Location_____

Crew Leader_____

Crew Members_____

_____

Log Book: Up to date Yes___ No___

Manual Present: Yes___ No___

GENERATOR/ALTERNATOR

___ 1. Electrical connections secure and protected
___ 2. Mountings secure
___ 3. Exhaust directed away from operator
___ 4. Frame properly grounded
___ 5. Unit electrically bonded/connected to frame

ELECTROFISHER

___ 1. Controls and gauges operational
___ 2. Adequate mechanical protection of wiring
___ 3. Adequate connectors and interlocking
___ 4. "KILL SWITCH" working
___ 5. Anode switches working
___ 6. Wiring to anodes in good condition
___ 7. Anodes in good condition - attached to handle securely
___ 8. No screens or nets attached to anode hoops
___ 9. Anode handles of non-conductive material
___ 10. Cathode plate clean - connection secure
___ 11. Anode cables unwound from coil - connections tight

ADDITIONAL EQUIPMENT

___ 1. Fire extinguisher fully charged
___ 2. First aid kit full
___ 3. Enough personal safety equipment present - gloves, boots, ear protection, PFDs (as necessary), polarizing sunglasses

Appendix 6. Daily back pack electrofisher field check list.

Unit Inv. #_____ Date_____

Time_____ Location_____

Crew Leader_____

Crew Members_____

_____

Log Book: Up to date Yes___ No___

Manual Present: Yes___ No___

BATTERY

___ 1. Clean and fully charged
___ 2. Terminals clean and tight

ELECTROFISHER

___ 1. Controls and gauges operational
___ 2. Adequate protection of wiring
___ 3. Adequate connectors and interlocking
___ 4. Visible voltage light working
___ 5. "KILL SWITCH" working
___ 6. Electrode switch working
___ 7. Wiring to anode in good condition
___ 8. Wiring to anode in good condition
___ 9. Electrodes in good condition - fastened securely

ADDITIONAL EQUIPMENT

___ 1. Fire extinguisher charged (if applicable)
___ 2. First aid kit full
___ 3. Personal safety gear - gloves, boots, PFDs (as needed), polarizing sunglasses

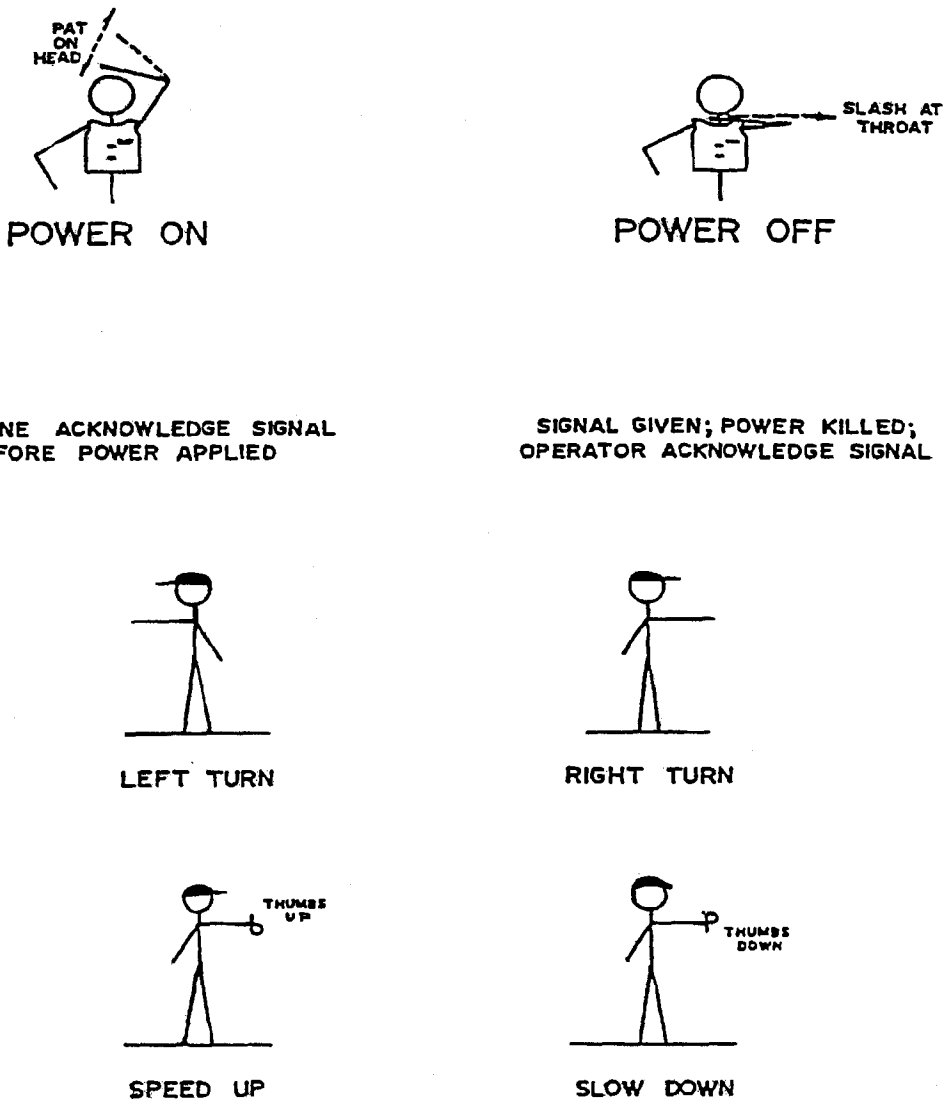


Figure 1. Electrofishing hand signals.

Minnesota DNR Volunteer Guidelines

General Definition

A volunteer project is a non-compensated activity or assistance provided by an individual or a group of individuals to accomplish a DNR-identified need.

Allowable Projects

1. Volunteers may be used in all parts of DNR projects management and operation.
2. All levels and types of skills may be used. A volunteer may perform any type of non-restricted work, provided it is work which supplements--not supplants--paid staff; and provided it is work which:
   a. Would not get done at the time because of funding and/or personnel limitations;
   b. Creates new projects or service;
   c. Fills gaps in existing projects or services; and
   d. Does not cause a layoff, or shorten an employee's work hours.
3. The DNR Bureau of Human Resources should be consulted when questions arise regarding labor relations.

Restricted Projects

1. No volunteer should be required to perform any type of work which he/she does not feel comfortable doing, or does not willingly agree to do.
2. No volunteer should be assigned to work for which he/she is not physically capable.
3. Volunteers may assist in certain law monitoring and regulation functions (i.e. reporting poachers, violations, etc.) but must not be assigned duties which would place them in a life-threatening situation. Volunteers may not issue citations or carry firearms.

Workers' Compensation

1. A person accepted as a volunteer for the Department of Natural Resources is considered an "employee" for Workers' Compensation.
2. See Minnesota Statutes 84.089 on "Volunteers in Natural Resources Program" and S176.011,Subdivision 9, for exact wording on Workers' Compensation.
3. Each unit using volunteers is financially responsible for its own Workers' Compensation claims.
4. "Notice of Enrollment in a Certified Managed Care Plan for Workers' Compensation Injuries and Illness" will be provided to each volunteer to read.

Court Ordered Community Service

Individuals working under the Sentence to Service (STS) Program or court ordered community service programs are NOT considered DNR volunteers. The Minnesota Department of Corrections is responsible for these people's Workers Compensation. Contact your DNR Region Administrator for the name of your regional STS Coordinator, or call John McLagen, STS Director, MN Dept. of Corrections, St. Paul, (651) 642-0335.

Campground Hosts

1. Campground Host programs are administered separately by the Divisions of Forestry, and Parks and Recreation, see their application forms for details.
2. Individuals accepted as Campground Hosts are considered DNR volunteers.

Safety

1. Volunteers must observe the same safety precautions and use the same safety equipment as employees.
2. Volunteers must not be assigned to hazardous work conditions unless the particular volunteer has special training and qualifications to perform such work.

Vehicles

When authorized by a supervisor, volunteers may drive state vehicles, while on state business, provided they have a valid driver's license. Volunteers may operate state equipment under the same rules and conditions as employees. Volunteers operating or riding in any vehicle, while on state business, are subject to the same seat belt requirements as are employees.

When driving state-owned vehicles, gasoline must be obtained from self-serve gasoline pumps at stations which will accept state credit cards.

People using their own personal vehicle on state business must carry their own personal auto insurance.

Equipment

Volunteers assigned to operate machinery or equipment (such as chain saws, power tools, specialized equipment, or vehicles) must have first demonstrated their proficiency in operation of that equipment to the satisfaction of the responsible supervisor. All applicable age and licensing restrictions and regulations related to the operation of machinery or equipment must be adhered to.

Use of Personal Property

Volunteers should use state-owned equipment and property in volunteer work, rather than their own personal property.

Reimbursement

Reimbursing the expenses of volunteers (meals, mileage, lodging, etc.) is at the discretion of the division/bureau based on their budget. Reimbursement conditions should be discussed with the volunteer.

Questions

Persons with questions on volunteer-related matters should consult DNR Volunteer Programs, 500 Lafayette Road, St. Paul, MN 55155-4036 (651) 297-1449 or (651) 297-3618 (Fax).

APPENDIX E: MN-DNR Electrofishing Guidelines

NA-03754-04 (REV 6/98)

DNR VOLUNTEER AGREEMENT

DNR Staff: Attach a copy of Volunteer Application with this agreement to officially "register" your volunteers for liability coverage. Keep these in your file. Provide a copy of "Notice of Enrollment in a Certified Managed Care Plan for Workers' Compensation Injuries and Illness" to volunteer.

Volunteer's Name			Volunteer's Address:
Type of Project			Volunteer Job Title
Specific Location of Work Site (if different than supervisor's address below)			
Purpose			
Duties			
Qualifications Desired (education, skill, experience)			
Division/Bureau/Unit	Region	Name of Supervisor/Contact Person	Title
Supervisor's Address (number and street, RFD, Box number, city state, zip code)			Telephone number ( )

Time Commitment: Negotiable? ☐ Yes ☐ No Dates of Project: From :_____ to _____

Minimum volunteer time commitment acceptable for this project: _____ ☐ Weekdays ☐ Evenings ☐ Weekends

Training Available? ☐ Yes ☐ No Reimbursement for Expenses: Mileage: ☐ Yes ☐ No Meals: ☐ Yes ☐ No

HARASSMENT: The Minnesota Department of Natural Resources (DNR) has adopted a statement of policy against harassment. The policy includes the procedures for reporting and resolving issues brought to the attention of the DNR. This policy statement can be found in the Minnesota DNR Affirmative Action Plan, July, 1993.

INTELLECTUAL PROPERTY RIGHTS: All right, title, and interest in all intellectual property which may be conceived or originate, either individually or jointly by others, and which arises out of the performance of my activities with the DNR, will be the property of the State of Minnesota and are hereby assigned to the State. I also agree, upon request of the State to execute all papers and perform all other acts necessary to assist the State to obtain and register copyrights and patents on such materials. Works of authorship created by me in the performance of my activities with the DNR shall be considered "works made for hire" as defined in the U.S. Copyright Act.

I have read, understand and agree to abide by these policies. If I am unable to meet my time commitment to this volunteer project I will contact my supervisor.

Volunteer's Signature	Date
If under 18 years, parent/guardian must approve and sign Parent/Guardian's Signature	Date

Minnesota Department of Natural Resources-Volunteer Programs
500 Lafayette Road, St. Paul, MN 55155-4036.
(651) 297-1449 or (651) 297-3618 FAX

APPENDIX E: MN-DNR Electrofishing Guidelines

NA-00103-03

VOLUNTEER REIMBURSEMENT REPORT

Print or Type

Name Last	First	M	Telephone Number (include area code)
Address (number and street, RFD, box number, City, State, and Zip Code)			
Volunteer Classification Position		Social Security Number (optional)	

EVENT			EXPENSES				
Date	Project or Activity	Miles	Miscellaneous Expenses (A) Item	Amount	Parking (B)	Fares (C)	Sub-totals (A thru C)
	Totals						

I declare under the penalties of perjury that this claim is just and correct

Volunteer's Signature	Date

DEPARTMENT SUPERVISOR TO COMPLETE THE FOLLOWING

DOC TYPE	DATE/VOUCHER NO.
P1	/
VENDOR CODE	DOCUMENT TOTAL

LINE	FUND	AGCY	ORG	APPR	ACTV	OBJ	RPTG	PROJ/JOB#

SUBORG	REFERENCE DOC: PO#	INVOICE

Total Expenses from Above $_____

Number of Miles: _____ @ _____per mile
$_____

TOTAL AMOUNT TO BE PAID $_____

APPROVED: Based on knowledge of the need for travel and expense, and on a compliance with all applicable travel regulations.

Supervisor's Signature	Date

NA-03752-04
Revised 7/93

VOLUNTEER TIME RECORD

Name of Volunteer	Address (No. & Street, Box No. RFD)	City	State	Zip Code
DNR Division/Bureau	Work Location (include city and zip code)	Supervisor's Name & Title		

Date (month/day/ year)	Time Begin	Time End	Hours per day	Tasks Performed/Accomplished	Comments

Total Hours on Page _____

Mail completed form to: Minnesota Department of Natural Resources, Volunteer Programs, Box 36, 500 Lafayette Road, St. Paul, MN 55155-4036

Provided by the Minnesota Department of Employee Relations

Notice of Enrollment in a Certified Managed Care Plan for Workers' Compensation Injuries and Illness

Notice of Enrollment in a Certified Managed Care Plan for Workers' Compensation Injuries and Illness

Under Minnesota Rule 5218.0250, the Minnesota Department of Employee Relations/Employee Insurance Division provides this notice to inform you that:

Effective January 1, 1998, your employer (the State of Minnesota) enrolled with **Comprehensive Managed Care (CMC)**, a certified workers' compensation managed care plan which provides state employees and covered volunteers with all necessary medical treatment for work-related injuries and illness.

If injured in the course of your work, you may receive treatment from a medical doctor, chiropractor, podiatrist, osteopath, or dentist; if the treatment is available within the community and is appropriate for the injury or illness. As a state employee or covered volunteer, you must receive such treatment from a health care provider who is a member of CMC's plan, except in the following circumstances: you have already established a treating relationship with a nonparticipating provider (who maintains your medical records)* prior to the work-related injury; or if you require emergency treatment; or if your place of employment and residence are beyond the mileage parameters set forth in part 5218.0100, subp. 1.F.(7). Furthermore, if you sustained your work related injury prior to the State's enrollment with CMC, you may continue to receive treatment from a non-participating provider until you change doctors.

You may access care for a work-related injury or illness by going to a clinic or health care provider from CMC's network; or by asking you agency's Workers' Compensation Coordinator to share CMC's provider directory with you; or by calling CMC's 24-hour Nurse Phone Line at 612-456-1950 or 800-486-2913. You may also contact CMC's Nurse Phone Line if you have questions about managed care for workers' compensation; or direct such inquiries to the State Workers' Compensation Program at 651-296-6521. You may also see your agency's Workers' Compensation Coordinator for information or assistance.

Additional information may be obtained by calling the Minnesota Department of Labor and Industry (DOLI) in St. Paul at 651-296-6107 or 800-342-5354. In Duluth, call DOLI at 218-723-4670 or 800-365-4584.

*In accordance with part 5218, subparts 1 and 2, except that if you later change doctors you must then choose a doctor who participates in CMC's plan.

Employee Insurance Division/Workers' Compensation
PO Box 64081, St. Paul, MN 55164-0081, (651) 296-6521 • TTY (651) 297-7959
• *An equal opportunity employer*

ACKNOWLEDGMENTS

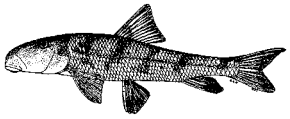
Jeff Gorton wrote the first version of this document. This version was updated by the members of the Electrofishing Committee: Huon Newburg, chair, Mark Ebbers, former chair, Jim Wolters, Doug Thompson, Deb Sewell, Mike McInerny, Bill Thorn, Mark Stopyro, Alan Anderson, Dave McCormack, and Jim Stewart. Ronald D. Payer, Steve Hirsch, Paul J. Wingate, and Charles Anderson provided comments and editorial assistance. The committee wishes to thank Vicky Schiller and Brenda Black for their clerical assistance.

Edited by:
P.J. Wingate, Fisheries Research Manager

State of Ohio
Environmental Protection Agency

Division of Surface Water

Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (QHEI)



June, 2006

Bob Taft, Governor
Joseph P. Koncelik, Director

Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (QHEI)

June 2006

OHIO EPA Technical Bulletin EAS/2006-06-1

Revised by the Midwest Biodiversity Institute[1] for:

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Division of Surface Water
Ecological Assessment Section
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Groveport, Ohio 43125

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Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (QHEI)

Introduction

This document summarizes the methodology for completing a general evaluation of macrohabitat, generally done by the fish field crew leader while sampling each location using the Ohio EPA Site Description Sheet - Fish (Appendix 1). This form is used to tabulate data and information for calculating the Qualitative Habitat Evaluation Index (QHEI). The following guidance should be used when completing the site evaluation form.

Header/Geographical Information

Complete site identification information is critical to making field data useful. Figure 1 illustrates the location information required for the QHEI.

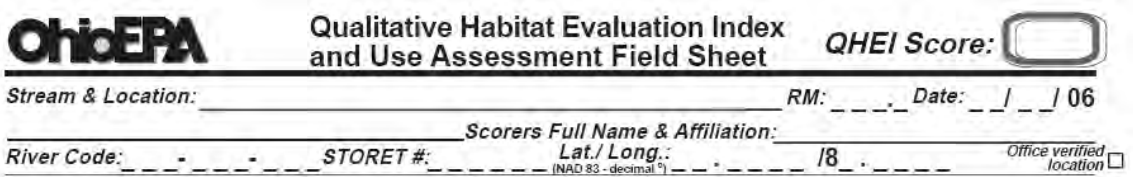


Figure 1. Header of Ohio EPA QHEI Sheet

1) Stream & Location, River Mile (RM), Date. The official stream name may be found in the Gazetteer of Ohio Streams (Ohio DNR 2001) or on USGS 7.5 minute topographic maps. If the stream is unnamed, a name and stream code is assigned by the Ohio ECOS Database Coordinator. Usually the name of a nearby landmark is used for the stream name. The River Mile (RM) designations used are found on 7.5 minute topo maps stored at the Ohio EPA, Division of Surface Water, Lazarus Government Center, Front Street (PEMSO RMI maps), one of five Ohio EPA District offices (maps for that district), and the Ohio EPA, Ecological Assessment Section at Grove City. These maps should soon be available as Adobe PDF files. A brief description of the sampling location should include proximity to a local landmark such as a bridge, road, discharge outfall, railroad crossing, park, tributary, dam, etc.

2) QHEI Scorers Full Name/Institution. The full name of the person who filled out the sheet are listed, along with the institution, company etc. QHEI information is to be completed someone who has successfully completed the QHEI training (e.g., crew leader). Ohio EPA will track the level of qualifications for each scorer. Level 2 QHEI practitioners have completed the two day training and successfully scored an additional site in a manner similar to EPA staff; Level 3 practitioners have additional training and have submitted three sites scored independently which will be verified as similar to EPA staff.

3) River Code, STORET, and Lat/Long. The River Code is Ohio EPA river code (PEMSO system) and the STORET # is the official unique Station Identifier used to link all data collected at a given "site" or "station" deemed to be similar for assessment purposes within a certain spatial area.

Habitat Characteristics: QHEI Metrics

The Qualitative Habitat Evaluation Index (QHEI) is a physical habitat index designed to provide an empirical, quantified evaluation of the general lotic macrohabitat characteristics that are important to fish communities. A detailed analysis of the development and use of the QHEI is available in Rankin (1989) and Rankin (1995). The QHEI is composed of six principal metrics each of which are described below. The maximum possible QHEI site score is 100. Each of the metrics are scored individually and then summed to provide the total QHEI site score. This is completed at least once for each sampling site during each year of sampling. An exception to this convention would be when substantial changes to the macrohabitat have occurred between sampling passes. Standardized definitions for pool, run, and riffle habitats, for which a

variety of existing definitions and perceptions exist, are essential for accurately using the QHEI. For consistency the following definitions are taken from Platts et al. (1983). It is recommended that this reference also be consulted prior to scoring individual sites.

Riffle and Run Habitats:

Riffle - areas of the stream with fast current velocity and shallow depth; the water surface is visibly broken.

Figure 2. Riffle cross-section.

Figure 3. Run cross-section.

Run - areas of the stream that have a rapid, non-turbulent flow; runs are deeper than riffles with a faster current velocity than pools and are generally located downstream from riffles where the stream narrows; the stream bed is often flat beneath a run and the water surface is not visibly broken.

Pool and Glide Habitats:

Pool - an area of the stream with slow current velocity and a depth greater than riffle and run areas; the stream bed is often concave and stream width frequently is the greatest; the water surface slope is nearly zero.

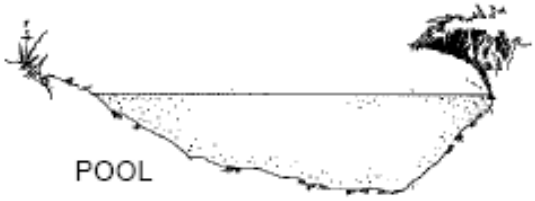


Figure 4. Pool cross-section.

Figure 5. Glide cross-section.

Glide - this is an area common to most modified stream channels that do not have distinguishable pool, run, and riffle habitats; the current and flow is similar to that of a canal; the water surface gradient is nearly zero. HINT: These habitat types typically grade into one another. For example a run gradually changes into a pool. When measuring typical depths of these features take measurements where the feature is clearly of that type, not where they are grading from one type to another. The following is a description of each of the six QHEI metrics and the individual metric components. Guidelines on how to score each is presented. Generally, metrics are scored by checking boxes. In certain cases the biologist completing the QHEI sheet may interpret a habitat characteristic as being intermediate between the possible choices; in cases where this is allowed (denoted by the term "Double-Checking") two boxes may be checked and their scores averaged.

Metric 1: Substrate (Figure 6).

This metric includes two components, substrate type[1] and substrate quality. **Substrate type** Check the two most common substrate types in the stream reach. If one substrate type predominates (greater than approximately 75- 80% of the bottom area OR what is clearly the most functionally predominant substrate) then this substrate type should be checked twice. **DO NOT CHECK MORE THAN TWO BOXES**. Note the category for artificial substrates. Spaces are provided to note the presence (by check marks, or estimates of % if time allows) of all substrate types present in pools (includes pools and glides) and riffles (includes riffles and runs) that each comprise sufficient quantity to support species that may commonly be associated with

[1] We suggest that QHEI practitioners should conduct some pebble count assessments which help calibrate an investigators ability to identify predominant substrates.

that substrate type. This section must be filled out completely to permit future analyses of this metric. If there are more than four or more high quality substrate types in the zone that are present in sufficient amounts (see above) then check the appropriate box for number of best types. This metrics award points to those sites with a diversity of high quality substrate types. Substrate origin refers to the parent material from which the substrate type(s) originated. This can be double-checked if two origin types are common (e.g., tills & limestone). See end of this section for some definitions.

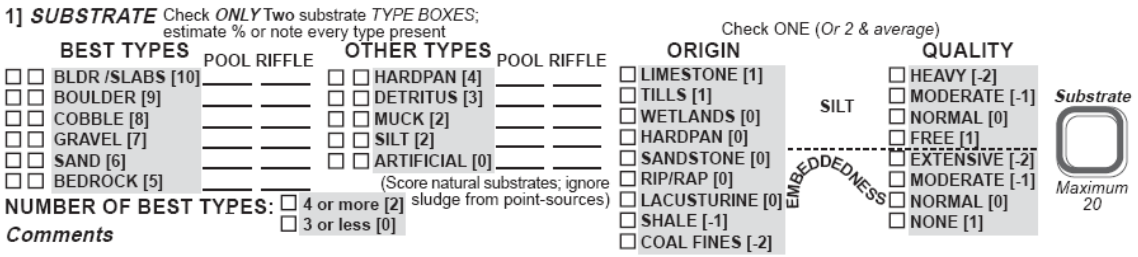


Figure 6. QHEI substrate metric.

Substrate quality.

Substrate origin refers to the "parent" material that the stream substrate is derived from. Check ONE box under the substrate origin column unless the parent material is from multiple sources (e.g., limestone and tills).

Embeddedness is the degree that cobble, gravel, and boulder substrates are surrounded, impacted in, or covered by fine materials (sand and silt). Substrates should be considered embedded if >50% of surface of the substrates are embedded in fine material. Embedded substrates cannot be easily dislodged. This also includes substrates that are concreted or "armor-plated". Naturally sandy streams are not considered embedded; however, a sand predominated stream that is the result of anthropogenic activities that have buried the natural coarse substrates is considered embedded.

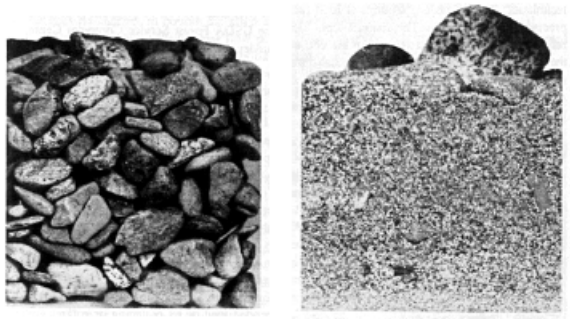


Figure 7. Side view of clearly un-embedded and embedded substrates.

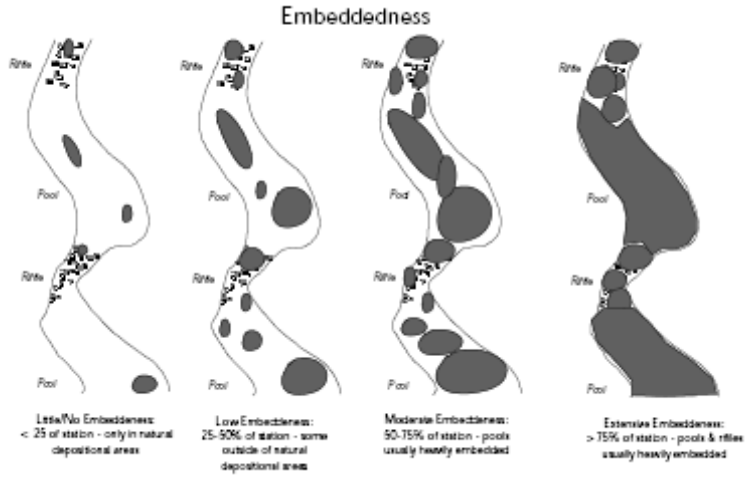


Figure 8. Illustration of example of degrees of pervasiveness of embeddedness for this QHEI component.

This can be very difficult to perceive. One help is to examine fresh point bars and look at the most common large materials that have been recently moved. According to Kappesser (1993), for gravel-bed rivers, the median of these large pieces should be equivalent to the median of the pieces on a riffle (based on a Wolman pebble count). If the riffles are finer than this, then sediment is aggrading in the reach and is evidence of embedded conditions. In some cases one can dig though the fine surface materials and fine coarser materials buried below. In this metric we are estimating the

pervasiveness of embedded conditions through-out a station. Boxes are checked for extensiveness (*i.e.*, pervasiveness throughout the area of the sampling zone) of the embedded substrates as follows: Extensive – > 75% of site area, Moderate – 50-75%, Normal[2] – 25-50%, None[3] – < 25%.

Silt Cover is the extent that substrates are covered by a silt layer (*i.e.*, a 1 inch thick or obviously affecting aquatic habitats). Silt cover differs from the embeddedness metric in that it only considers the fine silt size particles whereas fine gravels, sands, and other fines are considered in assessing embedded conditions. **Silt Heavy** means that nearly the entire stream bottom is layered with a deep covering of silt. (pool/glides and all but the fastest areas of riffle/runs). **Moderate** means extensive covering by silts, but with some areas of cleaner substrate (*e.g.*, riffles). **Normal** silt cover includes areas where silt is deposited in small amounts along the stream margin or is present as a "dusting" that appears to have little functional significance. If substrates are exceptionally clean the **Silt Free** box should be checked.

Figure 9. Illustration of example of degrees of pervasiveness of silt cover.

Substrate types are defined as:
a) **Bedrock** - solid rock forming a continuous surface.
b) **Boulder** - rounded stones over 256 mm in diameter (10 in.) or large "slabs" more than 256 mm in length (Boulder slabs)[4].
c) **Cobble** - stones from 64- 256 mm (2 1/2 - 10 in.) in diameter.
d) **Gravel** - mixture of rounded course material from 2-64 mm (1/12 - 2 1/2 in.) in diameter. Note the wide range of sizes included under gravel. In the riffle metric we distinguish between large and fine gravels
e) **Sand** - materials 0.06 - 2.0 mm in diameter, gritty texture when rubbed between fingers.
f) **Silt** - 0.004 - 0.06 mm in diameter, generally this is fine material which feels "greasy" when rubbed between fingers.
g) **Hardpan** - particles less than 0.004 mm in diameter, usually clay, which forms a dense, gummy surface that is difficult to penetrate.
h) **Marl** - calcium carbonate; usually grayish-white; often contains fragments of mollusk shells.
i) **Detritus** - dead, unconsolidated organic material covering the bottom which could include sticks, wood and other partially or un-decayed coarse plant material.
j) **Muck** - black, fine, flocculent, completely decomposed organic matter (does not include sewage sludge).
k) **Artificial** - substrates such as rock baskets, gabions, bricks, trash, concrete etc., placed in the stream for reasons OTHER than habitat mitigation.

Sludge is defined as a thick layer of organic matter that is decidedly of human or animal origin. NOTE: SLUDGE THAT ORIGINATES FROM POINT SOURCES IS NOT INCLUDED; THE SUBSTRATE SCORE IS BASED ON THE UNDERLYING MATERIAL. This scenario is rare today and was done to prevent underestimating stream habitat potential affect by discharges.

Substrate Metric Score: Although the sum of the individual metric scores can be greater than 20 the maximum substrate core allowed for this metric is 20 points.

[2] In some earlier training materials "normal" was described as "low" (e.g., see Figure 7).
[3] In some earlier training materials "None" was described as "little-no" (e.g., see Figure 7).
[4] A version of the QHEI used in Maine distinguishes large boulders.

Example of stream with heavily embedded substrates.

Example of spongy deposits of fine gravels and sands from recent erosion activities.

Substrate Origin Identification Tips:

- Limestone: Often contains fossils, easily scratched with knife, usually bedrock or flat boulders and cobbles
- Tills: Sediments deposited by glaciers; particles often rounded. Can be carried into non-glaciated areas
- Wetlands: Usually organic muck and detritus
- Hardpan: Clay – smooth, usually slippery
- Sandstone: Contains rounded fragment of sand "cemented" together
- Rip/Rap: Artificial boulders
- Lacustrine: Old lake bed sediments
- Shale: "Claystone," sedimentary rock made of silt/clay, soft and cleaves easily
- Coal Fines: Black fragments of coal, generally SE Ohio only

We suggest that QHEI practitioners gain some experience in pebble count procedures. Conducting Wolman or Zig-Zag pebble counts helps to improve the ability to visually estimate predominant substrate sizes and size categories.

Stream characterized by cobble and boulder-size substrates.

2] *INSTREAM COVER* Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

AMOUNT
Check ONE (*Or 2 & average*)
☐ EXTENSIVE >75% [11]
☐ MODERATE 25-75% [7]
☐ SPARSE 5-<25% [3]
☐ NEARLY ABSENT <5% [1]

____ UNDERCUT BANKS [1]
____ OVERHANGING VEGETATION [1]
____ SHALLOWS (IN SLOW WATER) [1]
____ ROOTMATS [1]
____ POOLS > 70cm [2]
____ ROOTWADS [1]
____ BOULDERS [1]
____ OXBOWS, BACKWATERS [1]
____ AQUATIC MACROPHYTES [1]
____ LOGS OR WOODY DEBRIS [1]

Comments

Cover Maximum 20

Figure 10. Instream cover (structure) metric.

Metric 2: Instream Cover (Figure 10).

This metric scores presence of instream cover types and amount of overall instream cover. Ohio EPA has been phasing in an alternative scoring system for this metric, but for this 2006, the total scoring still follows the existing methods. The changes will be discussed later.

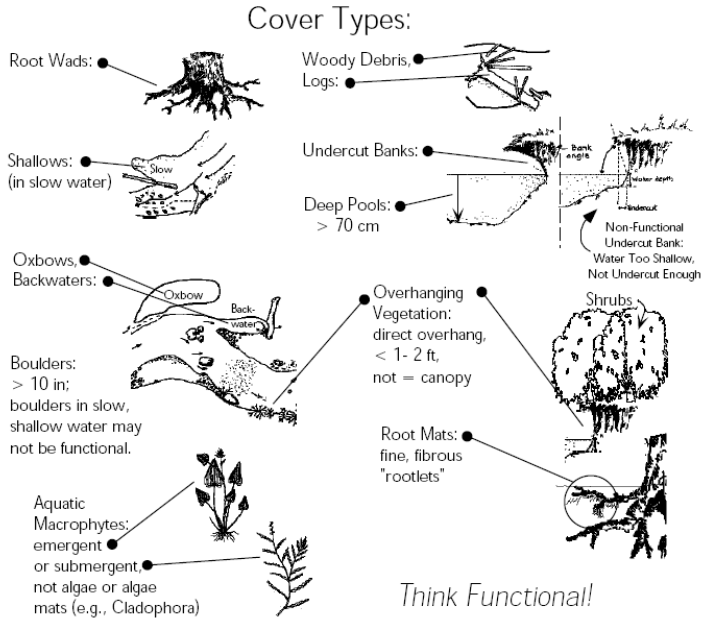


Figure 11. Examples of major cover/structure types measured with QHEI.

Existing Scoring Method:
Each cover type that is present in an amount occurs in sufficient quantity to support species that may commonly be associated with the habitat type should be scored.[5] Cover should not be counted when it is in areas of the stream with insufficient depth (usually < 20 cm) to make it useful. For example a logjam in 5 cm of water contributes very little, if any cover, and at low flow may be dry. Other cover types with limited function in shallow water include undercut banks and overhanging vegetation, boulders, and rootwads. Under amount, one or two boxes may be checked. Extensive cover is that which is present throughout the sampling area, generally greater than about 75% of the stream reach sampled. Cover is moderate when it occurs over 25- 75% of the sampling area. Cover is sparse when it is present in less than 25% of the stream margins (sparse cover usually exists in one or more isolated patches). Cover is nearly absent when no large patch of any type of cover exists anywhere in the sampling area. This situation is usually found in recently channelized streams or other highly modified reaches (e.g. ship channels). If cover is thought to be intermediate in amount between two categories, check two boxes and average their scores. For wide streams cover amount is estimated along the swath of stream sampled (or that would be sampled) with an electrofisher. In smaller streams

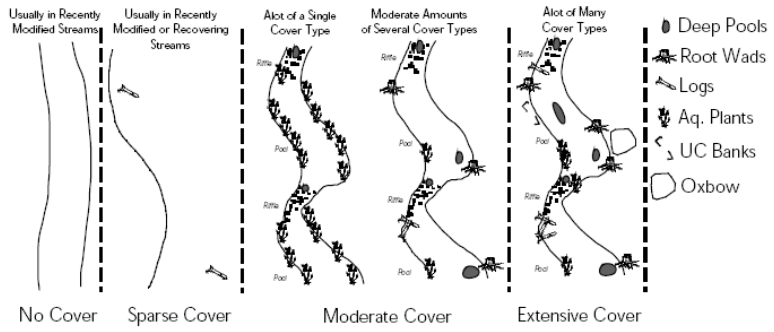


Figure 12. Illustration of the four categories of cover amounts.

[5] We had mentioned a 5% rule of thumb for an amount threshold if biological experience is low – this would be as a linear, not an areal amount.

(smaller wadeable and headwater streams) this generally covers most of the stream width. If a single type of cover is extensive and others are absent or uncommon then the total is scored as moderate because of the low diversity of types.

A desire to investigate and measure variation in amount and quality of individual cover types lead to a change in scoring of this metric. Over the next year or so the existing scoring method (each cover type scored on an presence/absence rating and a cumulative cover amount score) will be replaced with the following scoring method that focuses on scoring each cover type on a gradient of amount and quality. Each cover type would receive a score of 0-3 where:

0 - Absent;
1 - Very small amounts or if more common of marginal quality;
2 - Moderate amounts, but not of highest quality or in small amounts of highest quality;
3 - Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter logs that are stable, well developed rootwads in deep/fast water, or deep, well-defined, functional pools.

The cover ratings have been collected for about the last five years and an assessment of their relation to biological measures will be used to adjust a final scoring for this metric. At present, continue scoring these as present/absent and use the overall cover metric score. Cover types include: 1) undercut banks, 2) overhanging vegetation, 3) shallows (in slow water)[6], 4) logs or woody debris, 5) deep pools (> 70 cm), 6) oxbows, backwaters, or side channels, 7) boulders, 8) aquatic macrophytes, and 9) rootwads (tree roots that extend into stream). Do not check undercut banks AND rootwads unless undercut banks exist along with rootwads as a major component. Although the theoretical maximum score is > 20 the maximum score assigned for the QHEI for the instream cover metric is limited to 20 points.

High quality logs and woody debris in deep water.

High quality rootwad in deep, fast water.

[6] Shallows are habitats that provide nursery areas for small fish.

Example of good quality shallow habitat with aquatic macrophyte bed that acts as nursery habitat.

High quality boulder in fast water

Root Mats

Importance of logs and woody debris in large rivers.

Functional overhanging vegetation

Metric 3: Channel Morphology (Figure 13)

This metric emphasizes the quality of the stream channel that relates to the creation and stability of macrohabitat. It includes channel sinuosity (i.e. the degree to which the stream meanders), channel development, channelization, and channel stability. One box under each should be checked unless conditions are considered to be intermediate between two categories; in these cases check two boxes and average their scores.

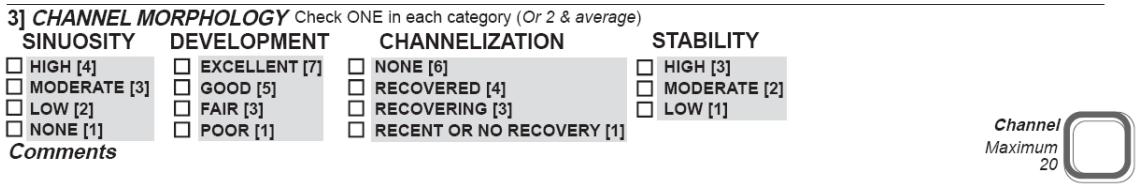


Figure 13. Channel morphology metric.

a) *Sinuosity* - **No sinuosity** is a straight channel. **Low sinuosity** is a channel with only 1 or 2 poorly defined outside bends in a sampling reach, or perhaps slight meandering within modified banks. **Moderate sinuosity** is more than 2 outside bends, with at least one bend well defined. **High sinuosity** is more than 2 or 3 well defined outside bends with deep areas outside and shallow areas inside. Sinuosity may be more conceptually described by the ratio of the stream distance between two points on the channel of a stream and the straight-line distance between these same two points, taken from a topographic map. This metric measures the formation of pools and increased habitat area as the primary "functions" of sinuosity as related to aquatic life. Check one box or select two and average.

b) *Development* - This refers to the development of riffle/pool complexes. **Poor** means riffles are absent, or if present, shallow with sand and fine gravel substrates; pools, if present are shallow. Glide habitats, if predominant, receive a **Poor** rating. **Fair** means riffles are poorly developed or absent; however, pools are more developed with greater variation in depth. **Good** means better defined riffles present with larger substrates (gravel, rubble or boulder); pools have variation in depth and there is a distinct transition between pools and riffles. **Excellent** means development is similar to the **Good** category except the following characteristics must be present: pools must have a maximum depth of >1 m and deep riffles and runs (>0.5 m) must also be present. In streams sampled with wading methods, a sequence of riffles, runs, and pools must occur more than once in a sampling zone. Check one box or check two and average.

Table 1: Scoring criteria for pool/riffle development metric.

	Excellent	Good	Fair	Poor
Pool	> 1 m deep, well defined	0.7-1.0 m deep, well defined	Some depth variation	Shallow, if present
Glide	Not common	Not common	Common	Predominant
Riffle	Deep, well defined riffles, large substrates	Defined riffles, large substrates	Poorly defined riffles or riffles absent	Absent of shallow with fine substrates
Run	> 0.5 m deep, well defined	Deep, well defined	Usually absent	Absent

This metric can be double-checked. For situations, for example where riffles are excellent and pools are only fair, it is advantageous to check the excellent and the fair box rather than checking the good box as an average to keep information on the variance in quality.

Note how well defined (i.e., distinct) the riffle and pool are in this high quality headwater stream pictured on the left. Also note the large tree in the riparian

c) *Channelization* - This refers to anthropogenic channel modifications. **Natural** refers to no obvious direct moving or alteration of the channel and a natural appearance. **Recovered** refers to streams that have been channelized in the past, but which have recovered most of their natural channel characteristics. **Recovering** refers to channelized streams which are still in the process of regaining their former, natural however, these habitats are still degraded. This category also applies to those streams, especially in the Huron/ Erie Lake Plain ecoregion (NW Ohio), that were channelized long ago and have a riparian border of mature trees, but still have Poor channel characteristics. **Recent** or **No Recovery** refers to streams that were recently channelized or those that show no significant recovery of habitats (e.g. drainage ditches, grass lined or rock rip-rap banks, etc.). The specific type of habitat modification is checked in the last two columns but not scored.

A channelized stream channel starting to revert towards more natural channel features.

Unstable channel features and low stability.

d) *Stability* - This refers to channel stability. Artificially stable (concrete) stream channels receive a High score. Even though they generally have a negative influence on fish assemblages, the negative effects are related to features other than their stability. Channels with **Low stability** are usually characterized by fine substrates in riffles that often change location, have unstable and severely eroding banks, and a high bedload that slowly creeps downstream. Sometimes these unstable riffles form diagonally across the channel (see figure, right). Channels with **Moderate stability** are those that appear to maintain stable riffle/ pool and channel characteristics, but which exhibit some symptoms of instability, e.g. high bedload, eroding or false banks, or shows the effects of wide fluctuations in water level. Channels with **High stability** have stable banks and substrates, and little or no erosion and bedload. e) *Modifications/Other* - Check the appropriate box if impounded, islands present, or leveed (these are not included in the QHEI scoring) as well as the appropriate source of habitat modifications. The maximum QHEI metric score for Channel Morphology is 20 points.

Metric 4: Riparian Zone and Bank Erosion (Figure 14)

This metric emphasizes the quality of the riparian buffer zone and quality of the floodplain vegetation. This includes riparian zone width, floodplain quality, and extent of bank erosion. Each of the three components requires scoring the left and right banks (looking downstream). The average of the left and right banks is taken to derive the component value. One box per bank should be checked unless conditions are considered to be intermediate between two categories; in these cases check two boxes and average their scores.

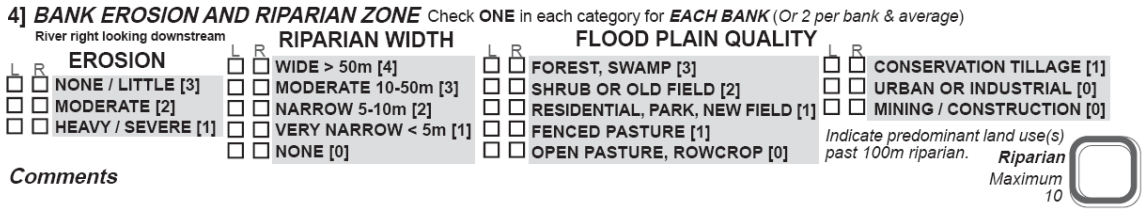


Figure 14. Bank erosion and riparian zone metric.

Severe bank erosion.

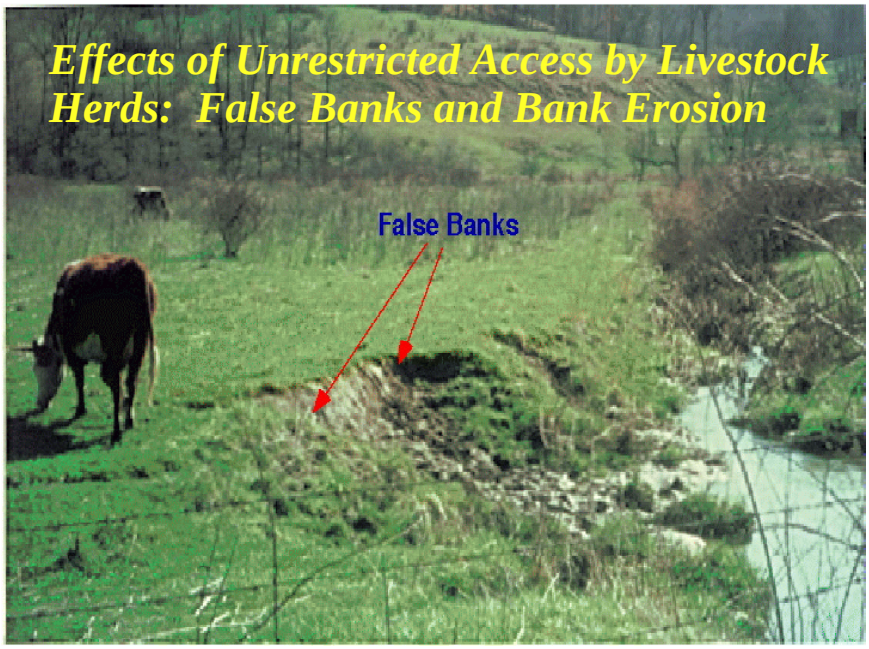
a) *Bank Erosion* – A modified Streambank Soil Alteration Ratings from Platts et al. (1983) is used here; check one box for each side of the stream and average the scores. False banks are used in the sense of Platts et al. (1983) to mean banks that are no longer adjacent to the normal flow of the channel but have been moved back into the floodplain most commonly as a result of livestock trampling. 1) **None** - streambanks are stable and not being altered by water flows or animals (e.g. livestock) - Score 3. 2) **Little** - streambanks are stable, but are being lightly altered along the transect line; less than 25% of the streambank is receiving any kind of stress, and if stress is being received it is very light; less than 25% of the streambank is false, broken down or eroding - Score 3. 3) **Moderate** - streambanks are receiving moderate alteration along the transect line; at least 50 percent of the streambank is in a natural stable condition; less than 50% of the streambank is false, broken down or eroding; false banks are rated as altered - Score 2. 4) **Heavy** - streambanks have received major alterations along the transect line; less than 50% of the streambank is in a stable condition; over 50% of the streambank is false, broken down, or eroding - Score 1. 5) **Severe** - streambanks along the transect line are severely altered; less than 25% of the streambank is in a stable condition; over 75% of the streambank is false, broken down, or eroding - Score 1

b) *Riparian Width* - This is the width of the riparian (stream side) vegetation. Width estimates are only done for **forest, shrub, swamp,** and **old field vegetation** if it has **woody** components (*e.g.*, willows). Old field refers to a fairly mature successional field that has stable, woody plant growth; this generally does not include weedy urban or industrial lots that often still have high runoff potential. Two boxes, one each for the left and right bank (looking downstream), should be checked and then averaged.

c) *Floodplain Quality* - The two most predominant floodplain quality types should be checked, one each for the left and right banks (includes urban, residential, etc.), and then averaged. By floodplain we mean the areas immediately outside of the riparian zone or greater than 100 meters from the stream, whichever is wider on each side of the stream. The concept is to identify land uses that might deliver harmful runoff to the stream. These are areas adjacent to the stream that can have direct runoff and erosion effects during normal wet weather. This is considered a ground truthing exercise and we suggest those interested in estimating of the effects of adjacent or riparian land uses use now well-developed GIS approaches. We do not limit it to the riparian zone and it is much less encompassing than the stream basin.

The maximum score for Riparian Zone and Erosion metric is 10 points.

Estimating riparian zone width.



Example of un-restricted livestock access and the formation of "false" banks.

Metric 5: Pool/Glide and Riffle-Run Quality (Figure 15)

This metric emphasizes the quality of the pool, glide and/or riffle-run habitats. This includes pool depth, overall diversity of current velocities (in pools and riffles), pool morphology, riffle-run depth, riffle-run substrate, and riffle-run substrate quality.

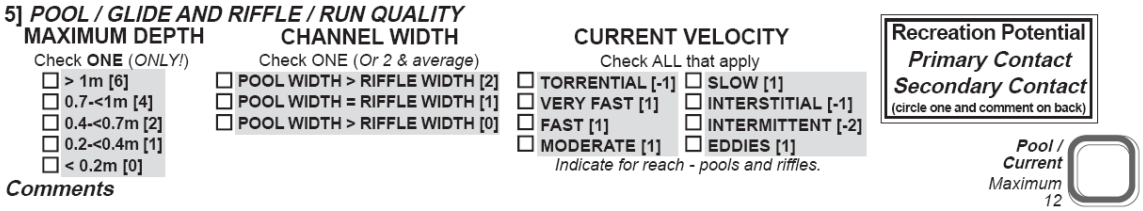


Figure 15. Pool/glide and riffle/run metric

A) Pool/Glide Quality

1) *Maximum depth* of pool or glide; check one box only (Score 0 to 6). Pools or glides with maximum depths of less than 20 cm are considered to have lost their function and the total metric is scored a 0. No other characteristics need be scored in this case.

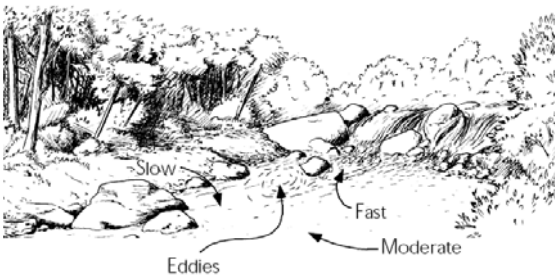


Figure 16. Typical locations of various current velocity types in a stream.

2) *Current Types* - check each current type that is present in the stream (including riffles and runs; score -2 to 4), definitions are: **Torrential** - extremely turbulent and fast flow with large standing waves; water surface is very broken with no definable, connected surface; usually limited to gorges and dam spillway tailwaters. **Very Fast** – turbulent flow that may make it difficult to stand and creates pulsating effect again leg. **Fast** - mostly non-turbulent flow with small standing waves in riffle/run areas; water surface may be partially broken, but there is a visibly connected surface. Fast current has sufficient energy to flow forcefully <u>over</u> objects. Sharp drop evident on depth rod. **Moderate** - non-turbulent flow that is detectable and visible (i.e. floating objects are readily transported downstream); water surface is visibly connected. With moderate current water flows around rather than over objects. Little drop around depth rod. **Slow** - water flow is perceptible, but very sluggish. **Eddies** - small areas of circular current motion usually formed in pools immediately downstream from riffle-run areas. **Interstitial** - water flow that is perceptible only in the interstitial spaces between substrate particles in riffle-run areas. **Intermittent** - no flow is evident anywhere leaving standing pools that are separated by dry areas. The role of bank erosion in sediment delivery to streams is often underestimated. Higher gradient stream showing typical locations of fast, moderate, and slow areas and eddies.

4) *Morphology* - Check **Wide** if pools are wider than riffles, **Equal** if pools and riffles are the same width, and **Narrow** if the riffles are wider than the pools (Score 0 to 2, see Figure 17). If the morphology varies throughout the site average the types. If the entire stream area (including areas outside of the sampling zone) is pool or riffle, then check riffle = pool.

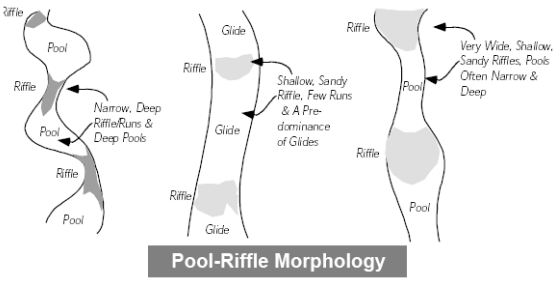


Figure 17. Pool morphology metric categories.

Although the theoretical maximum score for the pool metric is greater than 12 the maximum score assigned for the QHEI for the Pool Quality metric is limited to 12 points.

Illustration of the importance of pool depth to aquatic life

Estimating current velocity, Sharp drop from front to back of rod and boot indicates fast current velocities.

B) Riffle-Run Quality (Figure 18)

This entire metric is scored 0 if no riffles are present.

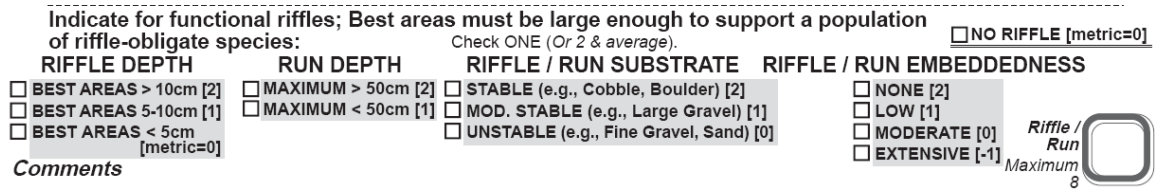


Figure 18. Riffle-run metric.

1)Riffle - select one box that most closely describes the depth characteristics of the best riffle in the zone (Score 0 to 2). The best riffle is selected because we want to identify bottlenecks during harsh periods (*e.g.*, drought). Estimate depths in areas that are clearly riffle, not transitional between a riffle and a run. If the riffle is generally less than 5 cm in depth, riffles are considered to have loss their function and the entire riffle metric is scored a 0.

2) Run Depth - select one box that most closely describes the depth characteristics of the runs (Score 0 to 2). Estimate depth in areas that are clearly run, not transitional between a pool and a run or a riffle and a run.

3) *Riffle/Run Substrate Stability*— select one box from each that best describes the substrate type and stability of the riffle habitats (Score 0 to 2).

4) *Riffle/Run Embeddedness*— Embeddedness is the degree that cobble, gravel, and boulder substrates are surrounded or covered by fine material (sand, silt); here in the riffle/runs only. We consider substrates embedded if >50% of surface of the substrates are embedded in fine material—these substrates cannot be easily dislodged. This also includes substrates that are concreted. Boxes are checked for pervasiveness of (riffle/ run area of sampling zone) embedded substrates: **Extensive** — > 75% of stream area, **Moderate** — 50-75%, **Sparse** — 25- 50%, **Low** — < 25%. The maximum score assigned for the QHEI for the Riffle/Run Quality metric is 8 points.

Metric 6: Map Gradient

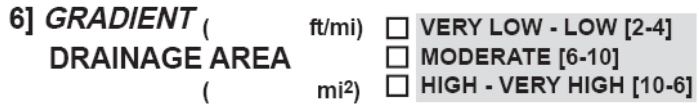


Figure 19. QHEI Stream gradient metric.

Local or map gradient is calculated from USGS 7.5 minute topographic maps by measuring the elevation drop through the sampling area. This is done by measuring the stream length between the first contour line upstream and the first contour line downstream of the sampling site and dividing the distance by the contour interval. If the contour lines are closely "packed" a minimum distance of at least one mile should be used. Some judgment may need to be exercised in certain anomalous areas (e.g. in the vicinity of waterfalls, impounded areas, etc.) and this can be compared to an infield, visual estimate which is recorded next to the gradient metric on the front of the sheet. Scoring for ranges of stream gradient takes into account the varying influence of gradient with stream size, preferably measured as drainage area in square miles or stream width. Gradient classifications (Table V-4-3) were modified from Trautman (p 139, 1981) and scores were assigned, by stream size category, after examining scatter plots of IBI vs. natural log of gradient in feet/mile (see Rankin 1989). Scores are listed in Table 2. The maximum QHEI metric score for Gradient is 10 points

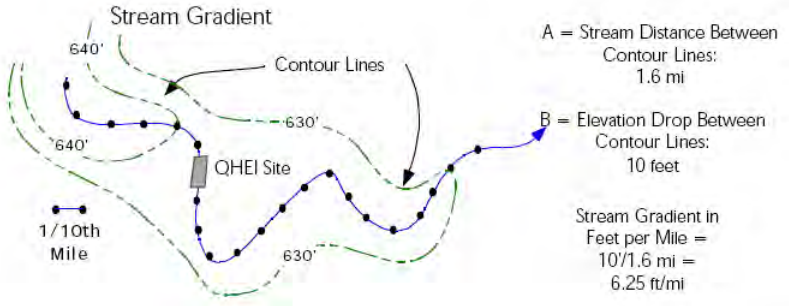


Figure 20. Illustration of methodology for determining stream gradient from topographic maps.

Table 2 Classification of stream gradients for Ohio by stream size. Modified from Trautman (p 139, 1981). Scores were derived from plots of IBI versus stream gradient for each stream size category.

Stream Width	Drainage Area (sq mi)	Gradient (feet/mile)						
		Very Low	Low	Low-Moderate	Moderate	Moderate-High	High	Very High[1]
≤ 4.7	< 9.2	0 - 1.0 **2**	1.1 - 5.0 **4**	5.1 - 10.0 **6**	10.1 - 15.0 **8**	15.1 - 20 **10**	20.1 - 30 **10**	30.1 - 40 **8**
4.8 - 9.2	9.2 - 41.6	0 - 1.0 **2**	1.1 - 3.0 **4**	3.1 - 6.0 **6**	6.1 - 12.0 **10**	12.1 - 18 **10**	18.1 - 30 **8**	30.1 - 40 **6**
9.3 - 13.8	41.7 - 103.7	0 - 1.0 **2**	1.1 - 2.5 **4**	2.6 - 5.0 **6**	5.1 - 7.5 **8**	7.6 - 12 **10**	12.1 - 20 **8**	20.1 - 30 **6**
13.9 - 30.6	103.8 - 622.9	0 - 1.0 **4**	1.1 - 2.0 **6**	2.1 - 4.0 **8**	4.1 - 6.0 **10**	6.1 - 10 **10**	10.1 - 15 **8**	15.1 - 25 **6**
> 30.6	> 622.9		0 - 0.5 **6**	0.6 - 1.0 **8**	1.1 - 2.5 **10**	2.6 - 4.0 **10**	4.1 - 9 **10**	> 9 **8**

[1]Any site with a gradient greater than the upper bound of the "very high" gradient classification is assigned a score of 4.

Computing the Total QHEI Score: To compute the total QHEI score, add the components of each metric to obtain the metric scores and then sum the metric scores to obtain the total QHEI score. The QHEI metric scores cannot exceed the Metric Maximum Score indicated below.

Narrative ranges of QHEI scores

For communicating general habitat quality to the public general narrative categories have been assigned to QHEI scores. Habitat influences on aquatic life, however, occur at multiple spatial scales and these narrative ranges are general and not always definitely predictable of aquatic assemblages are any given site.

Table 2. General narrative ranges assigned to QHEI scores. Ranges vary slightly in headwater (≤ 20 sq mi) vs. larger waters.

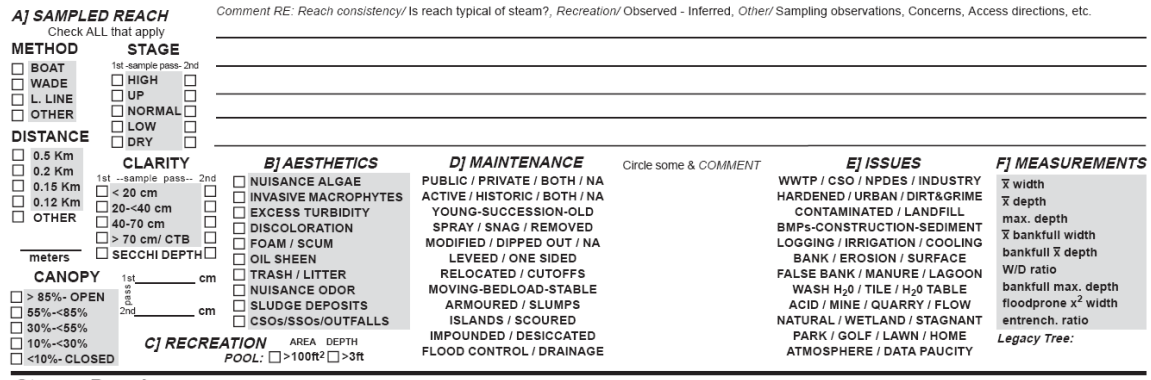
Narrative Rating	QHEI Range	
	Headwaters	Larger Streams
Excellent	≥ 70	≥ 75
Good	55- to 69	60 to 74
Fair	43 to 54	45 to 59
Poor	30 to 42	30 to 44
Very Poor	< 30	< 30

QHEI SCORING (Maximum = 100)

QHEI Metric	Metric Component	Component Scoring Range	Metric Max. Score
1) Substrate	a) Type b) Quality	0 to 21 -5 to 3	20
2) Instream Cover	a) Type b) Amount	0 to 10 1 to 11	20
3) Channel Morphology	a) Sinuosity b) Development c) Channelization d) Stability	1 to 4 1 to 7 1 to 6 1 to 3	20
4) Riparian Zone	a) Width b) Quality c) Bank Erosion	0 to 4 0 to 3 1 to 3	10
5a) Pool Quality	a) Max. Depth b) Current c) Morphology	0 to 6 -2 to 4 0 to 2	12
5b) Riffle Quality	a) Depth b) Substr Stab. c) Substr Embd.	0 to 4 0 to 2 -1 to 2	8
6) Gradient		2 to 10	10

Additional Information/Back of QHEI Sheet

Additional information is recorded on the reverse side of the Site Description Sheet. Several versions of the reverse of the QHEI sheet have been produced over the past 10 years, but this description is based on the most recent revision of the Ohio EPA sheet (Figure 21).



A – Sampling Characteristics

1) *Methods Used* – A series of check boxes to record the type of sampling completed in the reach.

2) *Distance* – Distance assessed for the QHEI and/or fish assessment.

3) *Stage* – Estimate of flow stage during assessment. Since some sites are sampled twice, a box is included for each sampling effort.

4) *Clarity* – Estimate of water clarity during assessment. Since some sites are sampled twice, a box is included for each sampling effort. There are also two places to record Secchi depths, if taken.

5) *Canopy* – Estimate of average width of canopy

B. Aesthetics

1) Check all of the boxes that apply in terms of aesthetic characteristics of the site

C. Recreation
1) Record whether there exists, within the area, greater than 100 ft^2 of water greater than three feet in depth. This is used to estimate whether full body immersion is possible or likely.

D. Maintenance
1) Record what types of stream maintenance activities or special features occur in the sampling zone. Some of this information was previously on the front of the sheet and is used as an aid when determining aquatic life uses (e.g., existing on ongoing channel maintenance).

E. Issues
1) Record various potential sources of impact that may occur in or near the site.

F. Measurements
1) If some quantitative measurements of stream channel characteristics are collected they may be recorded here. It is likely, however, that more detailed stream measurements (e.g., geomorphic assessment) will be recorded on separate forms.

G) *Stream Maps and Diagram*
Stream maps for each site can be very important. The act of drawing a map usually helps to identify habitat types scored with the QHEI. It can also help later samples identify sampling sites and determine whether changes have occurred. The level of detail of the drawings will likely vary with the objective. For example, sites assessed for 401 purposes should have as much detail as possible to help in later decisions of habitat limitations or high potential. Two or three cross-sections of the stream can provide useful information on the stream bank, stream bottom, stream channel, and floodplain characteristics.

QHEI Pool/Riffle Development Metric

Excellent Pool/Riffle Development:

Pools - > 1 m Deep
Glides - Only Transitional Habitats
Runs - > 0.5 m Deep
Riffles - Deep, Large Substrates
Morphology - All Habitats Easily Definable, Riffles Narrow and Deep, Pools Wide with Deep and Shallow Sections

Good Pool/Riffle Development:

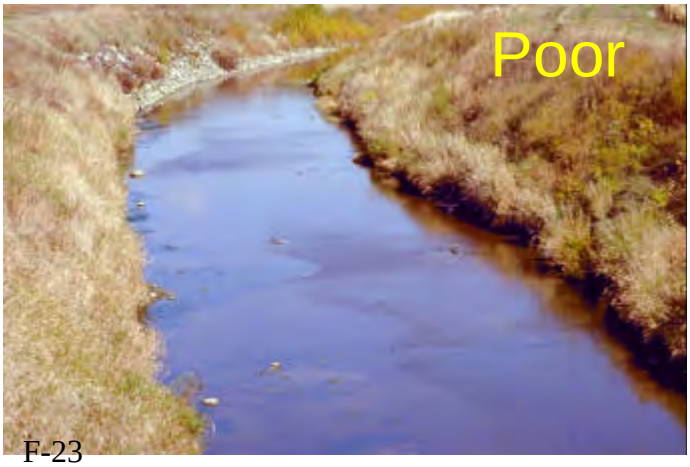
Pools - > 0.7 m Deep
Glides - Mostly Transitional Habitats
Runs - Deep, but < 0.5 m
Riffles - Some Deep Areas, Large Substrates (At Least Large Gravels)
Morphology - All Habitats Fairly Well Definable, Riffles Typically Narrower Than Most Pools

Fair Pool/Riffle Development:

Pools - Show Some Depth Variation
Glides - Common
Runs - Typically Absent
Riffles - Poorly Defined, Shallow
Morphology - Habitat Types Not As Distinct, Glides Typically Difficult to
Separate From Pools and Riffles

Poor Pool/Riffle Development:

Pools - Shallow if Present
Glides - Predominant
Runs - Absent
Riffles - Absent, Or if Present Unstable and Shallow With Fine Substrates
Morphology - Mostly Glide Characteristics, Riffles Ephemeral if Present



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Platts, W.S., W.F. Megahan, and G.W. Minshall. 1983. Methods for evaluating stream, riparian, and biotic conditions. U.S. Department of Agriculture, Forest Service, General Technical Report INT-138.

Rankin, E.T. 1989. The Qualitative Habitat Evaluation Index (QHEI): Rationale,methods, and application. Div. Water Qual. Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.

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Computing the macroinvertebrate IBI (mIBI)

NOTE: The text of this document and its associated tolerance lists were produced by IL EPA. The tolerance lists were included by IL EPA as Appendices A-1 and A-2. For the purposes of continuity within this QAPP, Lake County SMC has revised the text so that all references in the to the tolerance lists now refer to Appendices G-1 and G-2 and the tolerance lists were accordingly re-titled. No other changes were made to the content of this document.

The scale of measurement for mIBI is the sample reach. In this context, sample refers to the assemblage of macroinvertebrates collected with 20-jabs from one sample reach during a single sample event. The mIBI is unsupported if applied to composite assemblages taken from other spatial or temporal scales. See Section C of IEPA (1994) for sample collection guidelines. Thus, a correctly applied mIBI score estimates the level of biotic integrity at a sample site during one sample event. The 7 metrics used to compute the mIBI are: the number of Coleoptera taxa, the number of Ephemeroptera taxa, total number of Taxa, the number of Intolerant taxa, Macroinvertebrate Biotic Index (MBI), Percent individuals as Scrapers and Percent individuals as Ephemeroptera, Plecoptera or Trichoptera.

Data Resolution and Standardization

For mIBI computations, the underlying samples must have adequate and consistent taxonomic resolution. The required taxonomic resolution is genus for most organisms with less specific resolution allowed for members of some major groups. The following restrictions will apply for all mIBI computations. The first element in the data standardization process involves eliminating all Hemiptera and semi-aquatic Coleoptera from the underlying sample. Tolerance values, obtained from Appendix G-1 and G-2, identify semi-aquatic taxa. Semi-aquatic taxa have tolerance assignments of 99.9. The second element of the data standardization process requires classification of all members within the aquatic worm and leech groups as Oligochaeta, Turbellaria or Hirudinea. Similarly, classify all members within the Cambaridae, Sphaeriida and Unionidae groups as Cambaridae, Sphaeriidae or Unionidae. Collectively, the major groups refer to Oligochaeta, Turbellaria, Hirudinea, Cambariidae, Sphaeriidae and Unionidae and this level of organization applies for all metric calculations. In each case, determine the number of individuals for each major group, use Appendix G-1 and G-2 to apply functional feeding group (ffg) and tolerance value assignments that correspond with the Oligochaeta, Turbellaria, Hirudinea, Cambaridae, Sphaeriidae and Unionidae level of organization and calculate metrics accordingly. See the following sections for more information about metric computation. The third element in the data standardization process addresses individuals not previously described in the major group standardization. Identify these individuals at the genus level of taxonomic resolution. If damaged individuals are not confidently identified at the genus level, include these specimens at the most detailed taxonomic resolution possible. For taxa identified to genus and/or damaged individuals, use the corresponding ffg and/or tolerance value

assignments listed in Appendix G-1 and G-2. Ideally, a properly standardized sample should, therefore, include taxa identified and enumerated at the Oligochaeta, Turbellaria, Hirudinea, Cambaridae, Sphaeriidae and Unionidae major group level plus genus level identifications for all remaining taxa.

Computing Metric Values

Use the above described taxonomic standardization for all mIBI computations. Exclusive use of Appendix G-1 and G-2 for ffg and tolerance value assignments is required. In the following narrative, the terms "metric value" and "metric score" differ. The term "metric value" refers to the results obtained from metric formulas prior to metric standardization. For example, a properly standardized sample with six unique intolerant taxa has an intolerant taxa metric value of six. A "metric score" refers to a metric value after metric standardization. Metric standardization converts metric values, which represent various measurement units, to a single relative, unitless scale that can be aggragated. Per the above example with six unique intolerant taxa, the standardized metric score converts the raw metric value of six to a unitless relative percentage. Since the Best Value for intolerant taxa is nine, the standardized intolerant taxa score becomes 66.6 (6/9*100=66.6). The standardized metric score now has a unitless measurement scale that allows aggragation and gives rise to the multi-metric component and overall mIBI rating. As reiterated above, use Appendix G-1 and G-2 exclusively for data standardization, tolerance and ffg assignments. Use the following formulas to compute mIBI metrics:

Total Number of Taxa = $\sum$X

Where X is the number of "unique-members" in a data-standardized sample. Note that "double-counted" taxa may occasionally occur since damaged specimens that cannot be confidently identified to genus are included in the sample at a less detailed level of taxonomic resolution (e.g., family). Double-counted taxa will occur when these unidentifiable taxa are actually members of a genus already enumerated in the sample. For example, a sample with 12-*Stenacron sp*., 1-damaged Heptageniidae, and 6-*Baetis sp.*, will result in 3 total taxa- irrespective of the fact that the damaged Heptageniidae may actually be another *Stenacron sp.*.

Number of Coleoptera Taxa = $\sum$X

Where X is the number of "unique-member" Coleoptera taxa in a data-standardized sample. For this metric computation, follow the "unique member" identification instructions outlined in the Total number of Taxa formula and double-count example.

Number of Ephemeroptera Taxa = $\sum$X

Where X is the number of "unique-member" Ephemeroptera taxa in a data-standardized sample. For this metric, follow the "unique-member" identification

instructions outlined in the Total number of Taxa formula and double-count example.

Number of Intolerant Taxa = $\sum X$

Where X is the number of "unique-member" Intolerant taxa in a data-standardized sample. When computing this metric, follow the "unique-member" identification instructions outlined in the Total number of Taxa formula and double-count example. Identify intolerant taxa using tolerance values equal to or less than 3.0. Use Appendix G-1 and G-2 tolerance assignments exclusively. Tolerance values generally represent organism tolerance to deoxygenating waste and range from 0-11. The most tolerant individuals have a value of 11.0; decreased values indicate greater sensitivity to deoxygenating waste.

Macroinvertebrate Biotic Index = $\sum(n_i * t_i)/N$

Where n_i is the number of individuals in each data standardized taxon, t_i is the tolerance value assigned to that taxa and N is the total number of individuals in the sample. Use Appendix G-1 and G-2 tolerance assignments exclusively. Tolerance values generally represent organism tolerance to deoxygenating waste. Thus, the Macroinvertebrate Biotic Index (MBI) reflects taxon tolerance weighted by abundance. MBI scores range from 0-11. An MBI score of 11 represents the most perturbation with an assemblage dominated by taxa tolerant to low dissolved oxygen concentrations. On the other end of the spectrum, an MBI score of zero represents the least perturbation with an assemblage comprised of taxa extremely sensitive to reduced dissolved oxygen concentrations.

Percent individuals as Scrapers= $(n_i/N)*100$

Where n_i is the total number of individuals in the sample that have scraper functional feeding group assignments and N is the total number of individuals in the sample.

Percent individuals as Ephemeroptera, Plecoptera or Trichoptera = $(n_i/N)*100$

Where n_i is the total number of individuals in the sample that are members of the Ephemeroptera, Plecoptera or Trichoptera taxa groups and N is the total number of individuals in the sample.

Computing Metric Scores (Tetra Tech, 2004)

To allow meaningful comparisons and aggragation of metrics, use "best values" to convert metric values to a common unit of measure. Like the term implies, best values represent the best metric values one would typically expect to encounter. In addition, best values also help counter the effects of omitting rare taxa when fixed-count sub-

sampling is performed (Barbour and Yoder, 2006). Best values for each metric are listed in table 1.

Table 1. Best metric values.

Metric	Response to Perturbation	Best Value
Coleoptera taxa	Decrease	5
Ephemeroptera taxa	Decrease	10.2
Total Taxa	Decrease	46
Intolerant taxa	Decrease	9
MBI	Increase	4.9
Percent Scraper	Decrease	29.6
Percent EPT	Decrease	74

For metrics that decrease in value with perturbation, metric values greater than or equal to the standard best value receive a score of 100, those less than the best value are scored as a percentage of the best value:

$$\text{Standardized Score} = \frac{X - X_{min}}{X_{best} - X_{min}} * 100,$$

Where X is the metric value; X_{best} is the metric best value; and X_{min} is the metric minimum possible score (typically 0).

For those metrics that increase in value with perturbation (MBI), metric values less than or equal to the standard best value get a score of 100, those greater than the best value are scored as a percentage of the best value.

$$\text{Standardized Score} = \frac{X_{max} - X}{X_{max} - X_{best}} * 100,$$

Where X is the metric value; X_{best} is the metric best value; and X_{max} is the metric maximum possible score (e.g., 100 for percentage metrics).

Computing mIBI
Average the seven individual metric scores to obtain the mIBI score for the sample.

Interpreting mIBI
Following Table 2, scores closer to 100 are optimal.

Table 2 Macroinvertebrate IBI quality categories.

Index Score			
lower boundary	upper boundary	Comparison to Reference	Narrative Description
73.0	100.0	>75th percentile	Exceptional
41.8	72.9	>10th percentile	Good
20.9	41.7	bisect 10th percentile (upper)	Fair
0.0	20.8	bisect 10th percentile (lower)	Poor

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Appendix G-1
Phylogenetic Order
Macroinvertebrate tolerance and functional feeding group classification.

Taxa with tolerance values equal to 99.9 are excluded from all macroinvertebrate IBI computations. Scraper functional feeding group members are identified by the "SC" abbreviation.

Major Group	Bios ID	Taxon	Tolerance	Functional Feeding Group
Phylum Platyhelminthes	1	Platyhelminthes	99.9	
Class Turbellaria	2	Turbellaria	6	PR
Order Tricladida	3	Tricladida	6	CG
Family Planariidae	4	Planariidae	6	
	5	Dugesia sp.	6	
	6	Dugesia tigrina	6	PR
	7	Planaria sp.	6	
Phylum Nematomorpha	8	Nematomorpha	99.9	PA
Class Gordioida	9	Gordius	99.9	
Phylum Annelida	10	Annelida	99.9	CG
Class Oligochaeta	11	Oligochaeta	10	CG
Order Branchiobdellida	12	Branchiobdellida	10	PA
Family Branchiobdellidae	13	Branchiobdellidae	10	CG
Order Lumbriculida	14	Lumbriculida	10	
Family Lumbriculidae	15	Lumbriculidae	10	CG
Order Haplotaxida	16	Haplotaxida	10	
Family Aeolosomatidae	17	Aeolosomatidae	10	CF
Family Enchytraeidae	18	Enchytraeidae	10	CG
Family Lumbricidae	19	Lumbricidae	10	CG
Order Tubificida	20	Tubificida	10	CG
Family Naididae	21	Naididae	10	CG
	22	Allonais sp.	10	CG
	23	Allonais pectinata	10	
	24	Amphichaeta sp.	10	CG
	25	Amphichaeta leydigi	10	
	26	Arcteonais sp.	10	
	27	Arcteonais lomondi	10	CG
	28	Bratislavia sp.	10	CG
	29	Bratislavia unidentata	10	CG
	30	Chaetogaster sp.	10	SH
	31	Chaetogaster diaphanus	10	PR
	32	Chaetogaster diastrophus	10	PR
	33	Chaetogaster limnaei	10	PR
	34	Dero sp.	10	CG
	35	Dero digitata	10	CG
	36	Dero furcata	10	CG
	37	Dero lodeni	10	CG
	38	Dero nivea	10	CG
	39	Dero pectinata	10	CG

	40	Nais sp.	10	CG
	41	Nais barbata	10	CG
	42	Nais behningi	10	CG
	43	Nais bretscheri	10	CG
	44	Nais communis	10	CG
	45	Nais elinguis	10	CG
	46	Nais pardalis	10	CG
	47	Nais simplex	10	CG
	48	Nais variabilis	10	CG
	49	Paranais sp.	10	
	50	Paranais frici	10	
	51	Ophidonais sp.	10	
	52	Ophidonais serpentina	10	CG
	53	Pristina sp.	10	CG
	54	Pristina aequiseta	10	CG
	55	Pristina leidyi	10	CG
	56	Pristina breviseta	10	CG
	57	Pristina longiseta	10	
	58	Pristina osborni	10	CG
	59	Pristina synclites	10	CG
	60	Slavina sp.	10	CG
	61	Slavina appendiculata	10	CG
	62	Specaria sp.	10	CG
	63	Specaria josinae	10	CG
	64	Stephensoniana sp.	10	
	65	Stephensoniana trivandrana	10	CG
	66	Stylaria sp.	10	
	67	Stylaria fossularis	10	CG
	68	Stylaria lacustris	10	CG
	69	Uncinais sp.	10	
	70	Uncinais uncinata	10	
	71	Vejdovskyella sp.	10	CG
	72	Vejdovskyella intermedia	10	CG
	73	Wapsa sp.	10	
	74	Wapsa mobilis	10	
Family Tubificidae	75	Tubificidae	10	CG
	76	Aulodrilus pigueti	10	CG
	77	Branchiura sp.	10	CG
	78	Branchiura sowerbyi	10	CG
	79	Ilyodrilus sp.	10	
	80	Ilyodrilus templetoni	10	CG
	81	Limnodrilus sp.	10	CG
	82	Limnodrilus cervix	10	CG
	83	Limnodrilus claparedianus	10	CG
	84	Limnodrilus hoffmeisteri	10	CG
	85	Limnodrilus udekemianus	10	CG
	86	Tubifex sp.	10	CG
	87	Tubifex tubifex	10	CG
	88	Potamothrix vejdovskyi	10	
	89	Quistradrilus multisetosus	10	CG

Class Hirudinea	90	Hirudinea	8	PR
Order Rhynchobdellida	91	Rhynchobdellida	8	
Family Glossiphoniidae	92	Glossiphoniidae	8	PR
	93	Actinobdella sp.	8	
	94	Actinobdella inequiannulata	8	
	95	Alboglossiphonia sp.	8	
	96	Alboglossiphonia heteroclita	8	PR
	97	Batracobdella sp.	8	PR
	98	Batracobdella phalera	8	
	99	Batracobdella picta	8	
Family Erpobdellidae	100	Desserobdella phalera	8	
	101	Gloiobdella elongata	8	
Family Glossiphoniidae	102	Glossiphonia	8	PR
	103	Glossiphonia complanata	8	PR
	104	Helobdella sp.	8	PA
	105	Helobdella elongata	8	PR
	106	Helobdella fusca	8	PA
	107	Helobdella papillata	8	PR
	108	Helobdella stagnalis	8	PR
	109	Helobdella triserialis	8	PA
	110	Placobdella montifera	8	PR
	111	Placobdella sp.	8	PR
	112	Placobdella multilineata	8	PR
	113	Placobdella ornata	8	PR
	114	Placobdella papillifera	8	PA
	115	Placobdella parasitica	8	PA
	116	Placobdella pediculata	8	
	117	Theromyzon sp.	8	PR
	118	Theromyzon biannulatum	8	
Family Piscicolidae	119	Piscicolidae	7	
	120	Cystobranchus verrilli	7	
	121	Cystobranchus sp.	7	
	122	Myzobdella sp.	7	
	123	Myzobdella lugubris	7	PR
	124	Piscicola sp.	7	PR
	125	Piscicola milneri	7	PR
	126	Piscicola punctata	7	PR
	127	Piscicolaria sp.	7	
	128	Piscicolaria reducta	7	
Order Gnathobdellida	129	Gnathobdellida	8	PR
Family Hirudinidae	130	Hirudinidae	8	PR
	131	Haemopis sp.	7	PR
	132	Haemopis marmorata	7	
	133	Haemopis terrestris	7	
	134	Macrobdella sp.	7	
	135	Macrobdella decora	7	
	136	Philobdella sp.	7	
	137	Philobdella gracilis	7	PR
Order Pharyngobdellidae	138	Pharyngobdellidae	8	PR
Family Erpobdellidae	139	Erpobdellidae	8	PR

	140	Dina sp.	8	PR
	141	Dina dubia	8	
	142	Dina parva	8	
	143	Erpobdella sp.	8	
	144	Erpobdella punctata	8	PR
	145	Mooreobdella sp.	8	PR
	146	Mooreobdella fervida	8	
	147	Mooreobdella microstoma	8	PR
	148	Nephelopsis sp.	8	
	149	Nephelopsis obscura	8	PR
Phylum Arthropoda	150	Arthropoda	99.9	
Class Crustacea	151	Crustacea	99.9	CG
Order Isopoda	152	Isopoda	99.9	CG
Family Asellidae	153	Asellidae	6	CG
	154	Caecidotea sp.	6	CG
	155	Caecidotea brevicaudus	6	
	156	Caecidotea communis	6	CG
	157	Caecidotea forbesi	6	
	158	Caecidotea intermedia	6	
	159	Caecidotea kendeighi	6	
	160	Caecidotea tridentata	6	
	161	Caecidotea packardi	6	
	162	Caecidotea spatulata	6	
	163	Caecidotea stygia	6	
	164	Asellus communis	6	
	165	Asellus sp.	6	
	166	Asellus intermedius	6	
	167	Lirceus sp.	4	CG
	168	Lirceus fontinalis	4	CG
	169	Lirceus garmani	4	CG
	170	Lirceus lineatus	4	CG
	171	Lirceus louisianae	4	
Order Amphipoda	172	Amphipoda	4	CG
Family Talitridae	173	Hyalellidae	4	
	174	Hyalella sp.	4	CG
	175	Hyalella azteca	5	CG
Family Gammaridae	176	Gammaridae	4	CG
	177	Stygobromus sp.	4	PR
	178	Stygobromus subtilis	4	
	179	Bactrurus sp.	1	
	180	Crangonyx sp.	4	CG
	181	Crangonyx forbesi	4	CG
	182	Crangonyx gracilis	4	CG
	183	Crangonyx minor	4	
	184	Crangonyx packardi	4	
	185	Crangonyx pseudogracilis	4	
	186	Gammarus sp.	3	
	187	Gammarus pseudolimnaeus	3	CG
	188	Gammarus troglophilus	3	
	189	Gammarus fasciatus	3	CG

Order Decapoda	190	Decapoda	99.9	SH
Family Cambaridae	191	Cambaridae	5	CG
	192	Cambarellus sp.	5	SH
	193	Cambarellus puer	5	CG
	194	Cambarellus shufeldtii	5	CG
	195	Cambarus sp.	5	CG
	196	Cambarus diogenes	5	
	197	Cambarus rusticiformis	5	
	198	Cambarus tenebrosus	5	
	199	Fallicambarus sp.	5	
	200	Fallicambarus fodiens	5	
	201	Orconectes sp.	5	
	202	Orconectes illinoiensis	5	
	203	Orconectes immunis	5	
	204	Orconectes indianensis	5	
	205	Orconectes kentuckiensis	5	
	206	Orconectes lancifer	5	
	207	Orconectes placidus	5	
	208	Orconectes propinquus	5	
	209	Orconectes rusticus	5	
	210	Orconectes stannardi	5	
	211	Orconectes virilis	5	
	212	Orconectes bisectus	5	
	213	Procambarus sp.	5	SH
	214	Procambarus acutus	5	SH
	215	Procambarus clarki	5	
	216	Procambarus gracilis	5	
	217	Procambarus viaeviridis	5	
Family Palaemonidae	218	Palaemonidae	99.9	
	219	Palaemonetes sp.	4	
	220	Palaemonetes kadiakensis	4	
Class Insecta	221	Insecta	99.9	
Order Ephemeroptera	222	Ephemeroptera	3	CG
Family Siphlonuridae	223	Siphlonuridae	3	CG
	224	Acanthametropus sp.	3	PR
	225	Acanthametropus pecatonica	3	
	226	Ameletus sp.	0	CG
	227	Ameletus lineatus	0	
	228	Siphlonurus sp.	2	CG
	229	Siphlonurus alternatus	2	
	230	Siphlonurus quebecensis	2	
	231	Siphlonurus rapidus	2	
Family Oligoneuriidae	232	Oligoneuriidae	3	CF
	233	Isonychia sp.	3	CF
	234	Isonychia arida	3	
	235	Isonychia bicolor	3	CG
	236	Isonychia rufa	3	
	237	Isonychia sayi	3	
	238	Isonychia sicca	3	
Family Metretopodidae	239	Metretopodidae	3	

	240	Siphloplecton sp.	2	CG
	241	Siphloplecton basale	2	
	242	Siphloplecton interlineatum	2	
Family Baetidae	243	Baetidae	4	CG
	244	Acentrella sp.	4	
	245	Acerpenna sp.	4	SH
	246	Baetis sp.	4	CG
	247	Baetis amplus	4	CG
	248	Baetis armillatus	4	
	249	Baetis brunneicolor	4	CG
	250	Baetis ephippiatus	4	
	251	Baetis flavistriga	4	CG
	252	Baetis frondalis	4	
	253	Baetis hageni	4	CG
	254	Baetis intercalaris	7	
	255	Baetis levitans	4	
	256	Baetis longipalpus	6	
	257	Baetis macdunnoughi	4	CG
	258	Baetis propinquus	4	
	259	Acerpenna pygmaeus	4	
	260	Baetis quilleri	4	
	261	Baetis tricaudatus	1	CG
	262	Barbaetis cestus	4	
	263	Baetis vagans	4	
	264	Callibaetis sp.	4	CG
	265	Callibaetis ferrugineus	4	
	266	Callibaetis fluctuans	4	
	267	Callibaetis skokianus	4	
	268	Centroptilum sp.	2	CG
	269	Procloeon sp.	4	
	270	Cloeon sp.	3	
	271	Cloeon alamamce	3	
	272	Cloeon rubropictum	3	
	273	Heterocloeon sp.	4	SC
	274	Heterocloeon curiosum	4	SC
	275	Labiobaetis sp.	4	
	276	Labiobaetis propinquus	4	
	277	Plauditus sp.	3	
	278	Pseudocloeon sp.	4	SC
	279	Pseudocloeon carolina	4	
	280	Pseudocloeon dubium	4	SC
	281	Pseudocloeon myrsum	4	
	282	Pseudocloeon parvulum	4	
	283	Pseudocloeon punctiventris	4	
	284	Paracloeodes sp.	4	SC
	285	Paracloeodes minutus	5	
Family Heptageniidae	286	Heptageniidae	3.5	SC
	287	Anepeorus sp.	3.5	PR
	288	Anepeorus simplex	3.5	
	289	Arthroplea sp.	3	CF

	290	Arthroplea bipunctata	3	
	291	Epeorus sp.	1	SC
	292	Epeorus vitreus	0	
	293	Heptagenia diabasia	4	
	294	Nixe sp.	4	SC
	295	Nixe perfida	4	
	296	Heptagenia sp.	3	SC
	297	Heptagenia flavescens	2	
	298	Heptagenia hebe	3	
	299	Heptagenia lucidipennis	3	
	300	Heptagenia maculipennis	3	SC
	301	Heptagenia marginalis	1	SC
	302	Heptagenia perfida	1	
	303	Heptagenia pulla	0	SC
	304	Rhithrogena sp.	0	SC
	305	Rhithrogena pellucida	0	SC
	306	Stenacron sp.	4	SC
	307	Stenacron interpunctatum	4	
	308	Stenonema sp.	4	SC
	309	Stenonema ares	3	
	310	Stenonema exiguum	5	
	311	Stenonema quinquespinum	5	
	312	Stenonema femoratum	7	SC
	313	Stenonema integrum	4	
	314	Stenonema luteum	1	SC
	315	Stenonema mediopunctatum	2	SC
	316	Stenonema nepotellum	5	
	317	Stenonema modestum	3	SC
	318	Stenonema annexum	4	
	319	Stenonema pulchellum	3	SC
	320	Stenonema rubromaculatum	2	
	321	Stenonema terminatum	4	SC
	322	Stenonema vicarium	3	SC
Family Ephemerellidae	323	Ephemerellidae	3.5	CG
	324	Attenella sp.	2	CG
	325	Attenella attenuata	2	CG
	326	Dannella sp.	2	
	327	Dannella lita	2	CG
	328	Dannella simplex	2	CG
	329	Drunella sp.	1	PR
	330	Ephemerella cornuta	1	
	331	Drunella cornutella	1	SC
	332	Ephemerella lata	1	
	333	Ephemerella walkeri	1	
	334	Ephemerella sp.	2	CG
	335	Ephemerella aurivillii	2	CG
	336	Ephemerella catawba	2	CG
	337	Ephemerella dorothea	2	CG
	338	Ephemerella excrucians	2	CG
	339	Ephemerella invaria	2	CG

	340	Ephemerella needhami	2	CG
	341	Ephemerella rotunda	2	
	342	Ephemerella subvaria	2	CG
	343	Eurylophella sp.	4	SC
	344	Eurylophella aestiva	4	
	345	Eurylophella bicolor	4	CG
	346	Ephemerella coxalis	4	
	347	Eurylophella funeralis	4	
	348	Eurylophella lutulenta	4	CG
	349	Eurylophella temporalis	4	CG
	350	Serratella sp.	1	CG
	351	Serratella deficiens	1	CG
	352	Ephemerella frisoni	1	
	353	Serratella sordida	1	CG
Family Tricorythidae	354	Tricorythidae	5.5	CG
	355	Tricorythodes sp.	5	CG
Family Caenidae	356	Caenidae	5.5	CG
	357	Brachycercus sp.	3	CG
	358	Caenis sp.	6	CG
Family Baetiscidae	359	Baetiscidae	3	CG
	360	Baetisca bajkovi	3	
	361	Baetisca sp.	3	CG
	362	Baetisca lacustris	3	
	363	Baetisca laurentina	3	
	364	Baetisca obesa	3	
Family Leptophlebiidae	365	Leptophlebiidae	3	CG
	366	Choroterpes sp.	2	CG
	367	Choroterpes basalis	2	CG
	368	Habrophlebiodes sp.	2	SC
	369	Habrophlebiodes americana	2	
	370	Leptophlebia sp.	3	CG
	371	Paraleptophlebia sp.	2	CG
	372	Paraleptophlebia moerens	2	
	373	Paraleptophlebia ontario	2	
	374	Paraleptophlebia praepedita	2	
	375	Paraleptophlebia sticta	2	
Family Potamanthidae	376	Potamanthidae	5	CF
	377	Anthopotamus sp.	4	
	378	Potamanthus myops	4	
Family Ephemeridae	379	Ephemeridae	5	CG
	380	Ephemera sp.	3	CG
	381	Ephemera simulans	3	CG
	382	Hexagenia sp.	6	CG
	383	Hexagenia atrocaudata	6	CG
	384	Hexagenia bilineata	6	CG
	385	Hexagenia limbata	5	CG
	386	Hexagenia munda	5	
	387	Hexagenia rigida	6	CG
Family Palingeniidae	388	Pentagenia	4	CF
	389	Pentagenia vittigera	4	CG

Family Polymitarcyidae	390	Polymitarcyidae	3	CG
	391	Ephoron sp.	2	CG
	392	Ephoron album	2	CG
	393	Ephoron leukon	2	CG
	394	Tortopus sp.	4	CG
	395	Leucrocuta	3	SC
	396	Leucrocuta hebe	3	
	397	Leucrocuta maculipennis	3	
Order Odonata	398	Odonata	99.9	PR
Family Cordulegastridae	399	Cordulegastridae	4.5	PR
	400	Cordulegaster sp.	2	PR
	401	Cordulegaster maculata	2	PR
	402	Cordulegaster obliqua	2	PR
Family Gomphidae	403	Gomphidae	4.5	PR
	404	Erpetogomphus designatus	2	
	405	Dromogomphus sp.	4	PR
	406	Dromogomphus spinosus	4	PR
	407	Arigomphus sp.	7	PR
	408	Gomphus sp.	7	PR
	409	Gomphus amnicola	7	
	410	Gomphus crassus	7	
	411	Gomphus exilis	7	
	412	Gomphus externus	7	PR
	413	Gomphus graslinellus	7	
	414	Gomphus lentulus	7	
	415	Gomphus lineatifrons	7	
	416	Gomphus lividus	7	PR
	417	Gomphus notatus	7	
	418	Gomphus plagiatus	7	
	419	Gomphus quadricolor	7	
	420	Gomphus submedianus	7	
	421	Gomphus spiniceps	7	
	422	Gomphus vastus	7	PR
	423	Gomphus villosipes	7	
	424	Stylurus sp.	7	PR
	425	Gomphurus sp.	7	PR
	426	Hagenius sp.	3	PR
	427	Hagenius brevistylus	3	PR
	428	Lanthus sp.	6	PR
	429	Ophiogomphus sp.	2	PR
	430	Ophiogomphus rupinsulensis	2	
	431	Progomphus sp.	5	PR
	432	Progomphus obscurus	5	PR
	433	Stylogomphus sp.	4.5	PR
	434	Stylogomphus albistylus	4.5	PR
Family Aeshnidae	435	Aeshnidae	4.5	PR
	436	Aeschna sp.	4	PR
	437	Aeschna canadensis	4	
	438	Aeschna constricta	4	PR
	439	Aeschna umbrosa	4	

	440	Aeschna verticalis	4	
	441	Anax sp.	5	PR
	442	Anax junius	5	PR
	443	Basiaeschna sp.	2	PR
	444	Basiaeschna janata	2	PR
	445	Boyeria sp.	3	PR
	446	Boyeria vinosa	3	PR
	447	Epiaeschna sp.	1	PR
	448	Epiaeschna heros	1	PR
	449	Nasiaeschna sp.	2	PR
	450	Nasiaeschna pentacantha	2	PR
Family Macromiidae	451	Macromiidae	4.5	PR
	452	Didymops sp.	4	PR
	453	Didymops transversa	4	PR
	454	Macromia sp.	3	PR
	455	Macromia georgina	3	PR
	456	Macromia illinoiensis	3	PR
	457	Macromia pacifica	3	
	458	Macromia taeniolata	3	PR
Family Corduliidae	459	Corduliidae	4.5	PR
	460	Cordulia sp.	2	PR
	461	Cordulia shurtleffi	2	
	462	Epitheca sp.	4	PR
	463	Epicordulia sp.	4.5	PR
	464	Epicordulia princeps	4.5	PR
	465	Helocordulia sp.	2	PR
	466	Neurocordulia sp.	3	PR
	467	Neurocordulia molesta	3	PR
	468	Neurocordulia obsoleta	3	PR
	469	Neurocordulia yamaskanensis	3	
	470	Somatochlora sp.	1	PR
	471	Somatochlora filosa	1	
	472	Somatochlora linearis	1	PR
	473	Somatochlora tenebrosa	1	
	474	Tetragoneuria sp.	4.5	PR
	475	Tetragoneuria cynosura	4.5	PR
Family Libellulidae	476	Libellulidae	4.5	PR
	477	Celithemis sp.	2	PR
	478	Celithemis elisa	2	
	479	Celithemis eponina	2	
	480	Celithemis monomelaena	2	
	481	Erythemis sp.	5	PR
	482	Erythemis simplicicollis	5	PR
	483	Erythrodiplax sp.	5	PR
	484	Ladona sp.	4.5	PR
	485	Ladona julia	4.5	
	486	Leucorrhinia sp.	4.5	PR
	487	Leucorrhinia intacta	4.5	
	488	Libellula sp.	8	PR
	489	Libellula cyanea	8	

	490	Libellula incesta	8	PR
	491	Libellula luctuosa	8	
	492	Libellula pulchella	8	
	493	Libellula quadrimaculata	8	
	494	Libellula semifasciata	8	PR
	495	Libellula vibrans	8	PR
	496	Pachydiplax sp.	8	PR
	497	Pachydiplax longipennis	8	PR
	498	Pantala sp.	7	PR
	499	Pantala flavescens	7	
	500	Pantala hymenaea	7	
	501	Perithemis sp.	4	PR
	502	Perithemis tenera	4	PR
	503	Plathemis sp.	3	PR
	504	Plathemis lydia	3	PR
	505	Sympetrum sp.	4	PR
	506	Sympetrum ambiguum	4	PR
	507	Sympetrum corruptum	4	
	508	Sympetrum obstrusum	4	
	509	Sympetrum rubicundulum	4	
	510	Sympetrum semicinctum	4	
	511	Sympetrum vicinum	4	
	512	Tramea sp.	4	PR
	513	Tramea carolina	4	PR
	514	Tramea lacerata	4	
	515	Tramea onusta	4	
	516	Zygoptera sp.	99.9	PR
Family Calopterygidae	517	Calopterygidae	3.5	PR
	518	Calopteryx sp.	4	PR
	519	Calopteryx aequabilis	4	
	520	Calopteryx maculata	4	PR
	521	Hetaerina sp.	3	PR
	522	Hetaerina americana	3	PR
	523	Hetaerina titia	3	PR
Family Lestidae	524	Lestidae	99.9	PR
	525	Archilestes sp.	1	PR
	526	Archilestes grandis	1	
	527	Lestes sp.	6	PR
	528	Lestes disjunctus	6	
	529	Lestes eurinus	6	
	530	Lestes forcipatus	6	
	531	Lestes inaequalis	6	
	532	Lestes rectangularis	6	
	533	Lestes vigilax	6	
Family Coenagrionidae	534	Coenagrionidae	5.5	PR
	535	Amphiagrion sp.	5	PR
	536	Amphiagrion saucium	5	
	537	Anomalagrion sp.	5.5	PR
	538	Anomalagrion hastatum	5.5	PR
	539	Argia sp.	5	PR

	540	Argia apicalis	5	PR
	541	Argia bipunctulata	5	
	542	Argia moesta	5	PR
	543	Argia sedula	5	PR
	544	Argia tibialis	5	PR
	545	Argia translata	5	
	546	Argia violacea	5	PR
	547	Chromagrion sp.	5.5	PR
	548	Chromagrion conditum	5.5	
	549	Coenagrion sp.	5.5	PR
	550	Enallagma sp.	6	PR
	551	Enallagma aspersum	6	
	552	Enallagma civile	6	
	553	Enallagma divagans	6	PR
	554	Enallagma exsulans	6	
	555	Enallagma geminatum	6	
	556	Enallagma hageni	6	
	557	Enallagma signatum	6	PR
	558	Enallagma traviatum	6	
	559	Enallagma vesperum	6	PR
	560	Ischnura sp.	6	PR
	561	Ischnura posita	6	PR
	562	Ischnura verticalis	6	
	563	Nehalennia sp.	7	PR
	564	Nehalennia gracilis	7	
	565	Nehalennia irene	7	
Order Plecoptera	566	Plecoptera	1.5	PR
Family Pteronarcyidae	567	Pteronarcys	2	SH
Family Taeniopterygidae	568	Taeniopterygidae	1.5	SH
	569	Oemopteryx sp.	1.5	SH
	570	Oemopteryx glacialis	1.5	
	571	Strophopteryx sp.	1.5	
	572	Strophopteryx fasciata	1.5	SH
	573	Taeniopteryx sp.	2	SH
	574	Taeniopteryx nivalis	2	SH
	575	Taeniopteryx parvula	2	SH
Family Nemouridae	576	Nemouridae	1.5	SH
	577	Amphinemura sp.	1.5	SH
	578	Nemoura sp.	1	SH
	579	Nemoura venosa	1	
	580	Prostoia sp.	1.5	SH
	581	Soyedina sp.	1.5	SH
Family Leuctridae	582	Leuctridae	1.5	SH
	583	Leuctra sp.	1	SH
Family Capniidae	584	Capniidae	1.5	SH
	585	Allocapnia sp.	2	SH
	586	Allocapnia mystica	1.5	
	587	Allocapnia recta	1.5	
	588	Allocapnia vivipara	1.5	SH
	589	Capnia sp.	1	SH

	590	Capnia vernalis	1	
	591	Paracapnia sp.	1.5	SH
	592	Paracapnia angulata	1.5	
	593	Paracapnia opis	1.5	
Family Perlidae	594	Perlidae	1.5	PR
	595	Acroneuria sp.	1	PR
	596	Acroneuria abnormis	1	PR
	597	Acroneuria arida	1	PR
	598	Acroneuria carolinensis	1	PR
	599	Acroneuria evoluta	1	PR
	600	Acroneuria internata	1	PR
	601	Acroneuria lycorias	1	PR
	602	Attaneuria sp.	1.5	
	603	Attaneuria ruralis	1.5	PR
	604	Neoperla sp.	1	PR
	605	Neoperla clymene	1	PR
	606	Paragnetina sp.	1.5	PR
	607	Paragnetina media	1.5	PR
	608	Perlesta sp.	4	PR
	609	Atoperla sp.	1	
	610	Perlesta placida	4	
	611	Perlinella sp.	2	PR
	612	Perlinella drymo	2	PR
	613	Perlinella ephyre	2	PR
	614	Phasganophora sp.	1.5	PR
	615	Phasganophora capitata	1.5	
Family Perlodidae	616	Perlodidae	1.5	PR
	617	Hydroperla sp.	1	PR
	618	Hydroperla crosbyi	1	
	619	Isogenoides sp.	1.5	PR
	620	Isoperla sp.	2	PR
	621	Isoperla bilineata	2	
	622	Isoperla clio	2	
	623	Isoperla confusa	2	
	624	Isoperla cotta	2	
	625	Isoperla dicala	2	
	626	Isoperla lata	2	
	627	Isoperla marlynia	2	
	628	Isoperla nana	2	
	629	Isoperla richardsoni	2	
Family Chloroperlidae	630	Chloroperlidae	1.5	PR
	631	Chloroperla sp.	3	
	632	Alloperla sp.	1.5	PR
	633	Hastaperla sp.	1.5	SC
	634	Hastaperla brevis	1.5	
	635	Rasvena sp.	1.5	
	636	Rasvena terna	1.5	CG
Order Hemiptera	637	Hemiptera	99.9	PR
Family Hebridae	638	Hebridae	99.9	PR
	639	Hebrus sp.	99.9	PR

	640	Merragata sp.	99.9	PR
Family Mesoveliidae	641	Mesoveliidae	99.9	PR
	642	Mesovelia sp.	99.9	PR
	643	Mesovelia mulsanti	99.9	PR
Family Gerridae	644	Gerridae	99.9	PR
	645	Gerris sp.	99.9	PR
	646	Limnogonus sp.	99.9	PR
	647	Limnogonus hesione	99.9	
	648	Metrobates sp.	99.9	PR
	649	Rheumatobates sp.	99.9	PR
	650	Trepobates sp.	99.9	PR
Family Veliidae	651	Veliidae	99.9	PR
	652	Microvelia sp.	99.9	PR
	653	Rhagovelia sp.	99.9	PR
Family Notonectidae	654	Notonectidae	99.9	PR
	655	Buenoa sp.	99.9	PR
	656	Notonecta sp.	99.9	PR
Family Pleidae	657	Pleidae	99.9	PR
	658	Neoplea sp.	99.9	PR
	659	Neoplea striola	99.9	
Family Naucoridae	660	Naucoridae	99.9	PR
	661	Pelocoris sp.	99.9	PR
	662	Pelocoris femoratus	99.9	PR
Family Nepidae	663	Nepidae	99.9	PR
	664	Nepa sp.	99.9	PR
	665	Nepa apiculata	99.9	
	666	Ranatra fusca	99.9	PR
	667	Ranatra sp.	99.9	PR
	668	Ranatra kirkaldyi	99.9	PR
	669	Ranatra nigra	99.9	PR
Family Belostomatidae	670	Belostomatidae	99.9	PR
	671	Belostoma sp.	99.9	PR
	672	Belostoma flumineum	99.9	PR
	673	Lethocerus sp.	99.9	PR
	674	Lethocerus americans	99.9	
	675	Lethocerus griseus	99.9	
	676	Lethocerus uhleri	99.9	
Family Corixidae	677	Corixidae	99.9	PR
	678	Hesperocorixa sp.	99.9	PR
	679	Hesperocorixa interrupta	99.9	
	680	Hesperocorixa laevigata	99.9	
	681	Hesperocorixa lucida	99.9	
	682	Hesperocorixa nitida	99.9	
	683	Hesperocorixa obliqua	99.9	
	684	Hesperocorixa vulgaris	99.9	
	685	Palmacorixa sp.	99.9	PR
	686	Palmacorixa buenoi	99.9	
	687	Palmacorixa gilletteii	99.9	
	688	Palmacorixa nana	99.9	
	689	Ramphocorixa sp.	99.9	PR

	690	Ramphocorixa acuminata	99.9	
	691	Sigara sp.	99.9	PR
	692	Sigara alternata	99.9	
	693	Sigara compressoidea	99.9	
	694	Sigara hubbelli	99.9	
	695	Sigara modesta	99.9	
	696	Sigara signata	99.9	
	697	Trichocorixa sp.	99.9	PR
	698	Trichocorixa calva	99.9	
	699	Trichocorixa kanza	99.9	
	700	Trichocorixa macroceps	99.9	
Order Megaloptera	701	Megaloptera	3.5	
Family Sialidae	702	Sialidae	3.5	PR
	703	Sialis sp.	4	PR
	704	Sialis infumata	4	
	705	Sialis itasca	4	
	706	Sialis mohri	4	PR
	707	Sialis vagans	4	
	708	Sialis velata	4	
Family Corydalidae	709	Corydalidae	3	PR
	710	Chauliodes sp.	4	PR
	711	Chauliodes pectinicornis	4	PR
	712	Chauliodes rastricornis	4	PR
	713	Corydalus sp.	3	PR
	714	Corydalus cornutus	3	PR
	715	Nigronia sp.	2	PR
	716	Nigronia fasciatus	2	PR
	717	Nigronia serricornis	2	PR
Order Neuroptera	718	Neuroptera	99.9	PR
Family Sisyridae	719	Sisyridae	1	PR
	720	Climacea sp.	1	
	721	Climacea areolaris	1	
	722	Sisyra sp.	1	PR
	723	Sisyra vicaria	1	
Order Trichoptera	724	Trichoptera	3.5	
Family Hydropsychidae	725	Hydropsychidae	5.5	CF
	726	Cheumatopsyche sp.	6	CF
	727	Diplectrona sp.	2	CF
	728	Diplectrona metaqui	2	
	729	Diplectrona modesta	2	CF
	730	Hydropsyche sp.	5	CF
	731	Hydropsyche aerata	5	CF
	732	Hydropsyche arinale	5	
	733	Hydropsyche betteni	5	CF
	734	Hydropsyche bidens	5	
	735	Ceratopsyche alterans	4	
	736	Ceratopsyche cheilonis	4	
	737	Ceratopsyche morosa	4	
	738	Ceratopsyche bronta	4	CF
	739	Hydropsyche cuanis	5	

	740	Hydropsyche dicantha	5	CF
	741	Hydropsyche frisoni	5	CF
	742	Hydropsyche hageni	5	
	743	Hydropsyche incommoda	5	
	744	Ceratopsyche morosa	4	
	745	Hydropsyche morosa	4	CF
	746	Hydropsyche orris	4	CF
	747	Hydropsyche phalerata	2	CF
	748	Hydropsyche placoda	4	
	749	Ceratopsyche alhedra	4	
	750	Hydropsyche scalaris	5	CF
	751	Ceratopsyche alternans	5	CF
	752	Hydropsyche simulans	5	CF
	753	Hydropsyche valanis	5	CF
	754	Hydropsyche venularis	5	CF
	755	Macronema sp.	2	CF
	756	Macrostemum sp.	2	CF
	757	Macronema zebratum	2	CF
	758	Parapsyche sp.	5.5	PR
	759	Parapsyche apicalis	5.5	
	760	Potamyia sp.	4	CF
	761	Potamyia flava	4	CF
	762	Ceratopsyche sp.	4	CF
	763	Ceratopsyche alhedra	4	
	764	Ceratopsyche bronta	4	
	765	Ceratopsyche morosa	4	
	766	Ceratopsyche slossonae	4	
	767	Ceratopsyche sparna	4	
Family Philopotamidae	768	Philopotamidae	3.5	CF
	769	Chimarra sp.	3	CF
	770	Chimarra aterrima	3	CF
	771	Chimarra feria	3	CF
	772	Chimarra obscura	3	CF
	773	Chimarra socia	3	CF
	774	Dolophilodes sp.	0	CG
	775	Dolophilodes distinctus	0	
	776	Wormaldia sp.	3.5	CF
	777	Wormaldia shawnee	3.5	
Family Polycentropodidae	778	Polycentropodidae	3.5	CF
	779	Cyrnellus sp.	5	CF
	780	Cyrnellus fraternus	5	CF
	781	Neureclipsis sp.	3	CF
	782	Neureclipsis crepuscularis	3	CF
	783	Neureclipsis bimaculata	3	CF
	784	Nyctiophylax sp.	1	CF
	785	Phylocentropus sp.	3.5	CF
	786	Phylocentropus placidus	3.5	
	787	Polycentropus sp.	3	PR
	788	Polycentropus centralis	3	PR
	789	Polycentropus cinereus	3	PR

	790	Polycentropus flavus	3	PR
	791	Polycentropus glacialis	3	PR
	792	Polycentropus interuptus	3	PR
	793	Polycentropus remotus	3	PR
Family Psychomyiidae	794	Psychomyiidae	3.5	CG
	795	Lype sp.	3.5	SC
	796	Lype diversa	3.5	SC
	797	Psychomyia sp.	2	SC
	798	Psychomyia flavida	2	CG
Family Glossosomatidae	799	Glossosomatidae	3.5	SC
	800	Agapetus sp.	2	SC
	801	Agapetus illini	2	
	802	Glossosoma sp.	3.5	SC
	803	Glossosoma intermedium	3.5	SC
	804	Protoptila sp.	1	SC
Family Hydroptilidae	805	Hydroptilidae	3.5	PH
	806	Agraylea sp.	2	PH
	807	Agraylea multipunctata	2	
	808	Hydroptila sp.	2	SC
	809	Hydroptila waubesiana	2	
	810	Ithytrichia sp.	1	SC
	811	Leucotrichia sp.	3	SC
	812	Leucotrichia pictipes	3	
	813	Mayatrichia sp.	1	SC
	814	Mayatrichia ayama	1	SC
	815	Neotrichia sp.	4	SC
	816	Ochrotrichia sp.	4	CG
	817	Orthotrichia sp.	1	SC
	818	Oxyethira sp.	2	MH
	819	Stactobiella sp.	3.5	SH
	820	Stactobiella palmata	3.5	
Family Rhyacophilidae	821	Rhyacophilidae	3.5	PR
	822	Rhyacophila sp.	1	PR
	823	Rhyacophila fenestra	1	
	824	Rhyacophila fuscula	1	PR
	825	Rhyacophila lobifera	1	
	826	Rhyacophila vibox	1	
Family Brachycentridae	827	Brachycentridae	3.5	CF
	828	Brachycentrus sp.	1	CF
	829	Brachycentrus americanus	1	CF
	830	Brachycentrus lateralis	1	CF
	831	Brachycentrus numerosus	1	CF
	832	Brachycentrus occidentalis	1	CF
	833	Micrasema sp.	3.5	MH
	834	Micrasema rusticum	3.5	
Family Lepidostomatidae	835	Lepidostomatidae	3.5	SH
	836	Lepidostoma sp.	3	SH
	837	Lepidostoma liba	3	
Family Limnephilidae	838	Limnephilidae	3.5	SH
	839	Anabolia sp.	3.5	SH

	840	Frenesia sp.	3.5	SH
	841	Frenesia missa	3.5	
	842	Goera sp.	3.5	SC
	843	Hesperophylax sp.	3.5	SH
	844	Hesperophylax designatus	3.5	SH
	845	Hydatophylax sp.	2	SH
	846	Hydatophylax argus	2	SH
	847	Ironoquia sp.	3.5	SH
	848	Leptophylax sp.	3.5	SH
	849	Limnephilus sp.	3	SH
	850	Neophylax sp.	3	SC
	851	Neophylax concinnus	3	
	852	Platycentropus sp.	3	SH
	853	Platycentropus radiatus	3	
	854	Pseudostenophylax sp.	3.5	SH
	855	Pseudostenophylax uniformis	3.5	
	856	Pycnopsyche sp.	3	SH
	857	Pycnopsyche guttifer	3	SH
	858	Pycnopsyche lepida	3	
	859	Pycnopsyche luculenta	3	
	860	Pycnopsyche scabripennis	3	SH
	861	Pycnopsyche subfasciata	3	SH
Family Molannidae	862	Molannidae	3.5	CG
	863	Molanna sp.	3.5	SC
	864	Molanna blenda	3.5	
	865	Molanna tryphena	3.5	
	866	Molanna uniophila	3.5	
Family Phryganeidae	867	Phryganeidae	3.5	SH
	868	Agrypnia sp.	3	SH
	869	Agrypnia vestita	3	
	870	Banksiola sp.	2	SH
	871	Banksiola crotchi	2	
	872	Fabria sp.	3.5	SH
	873	Fabria inornatus	3.5	
	874	Oligostomis sp.	3.5	PR
	875	Oligostomis ocelligera	3.5	PR
	876	Phryganea sp.	3	
	877	Ptilostomis sp.	3	SH
Family Helicopsychidae	878	Helicopsychidae	3.5	SC
	879	Helicopsyche sp.	2	SC
	880	Helicopsyche borealis	2	SC
Family Leptoceridae	881	Leptoceridae	3.5	CG
	882	Ceraclea sp.	3	CG
	883	Ceraclea ancylus	3	
	884	Ceraclea cancellata	3	
	885	Ceraclea diluta	3	
	886	Ceraclea flava	3	
	887	Ceraclea maculata	3	
	888	Ceraclea nepha	3	
	889	Ceraclea transversa	3	

	890	Ceraclea resurgens	3	
	891	Leptocerus sp.	3	SH
	892	Leptocerus americanus	3	
	893	Mystacides sp.	2	CG
	894	Mystacides sepulchralis	2	
	895	Nectopsyche sp.	3	SH
	896	Nectopsyche albida	3	
	897	Nectopsyche candida	3	
	898	Nectopsyche diarina	3	
	899	Nectopsyche exquisita	3	
	900	Nectopsyche pavida	3	
	901	Oecetis sp.	5	PR
	902	Oecetis avara	5	PR
	903	Oecetis cinerascens	5	PR
	904	Oecetis eddlestoni	5	PR
	905	Oecetis inconspicua	5	PR
	906	Oecetis nocturna	5	
	907	Oecetis ochracea	5	
	908	Setodes sp.	3.5	
	909	Triaenodes sp.	3	MH
	910	Triaenodes injustus	3	
	911	Triaenodes marginatus	3	sh
	912	Triaenodes tardus	3	SH
Family Sericostomatidae	913	Sericostomatidae	3.5	SH
	914	Agarodes distincta	3.5	
Order Lepidoptera	915	Lepidoptera	99.9	SH
Family Pyralidae	916	Pyralidae	99.9	SH
	917	Munroessa sp.	99.9	SH
	918	Nymphula sp.	99.9	SH
	919	Paraponyx sp.	99.9	SH
	920	Petrophila sp.	5	SC
	921	Synclita sp.	99.9	SH
Order Coleoptera	922	Coleoptera	99.9	PR
Family Gyrinidae	923	Gyrinidae	99.9	PR
	924	Dineutus sp.	4	PR
	925	Dineutus assimilis	4	PR
	926	Dineutus discolor	4	PR
	927	Gyrinus sp.	4	PR
	928	Gyrinus aeneolus	4	PR
	929	Gyrinus analis	4	
Family Psephenidae	930	Psephenidae	4	SC
	931	Psephenus sp.	4	SC
	932	Psephenus herricki	4	SC
Family Scirtidae	933	Helodidae	7	SC
	934	Cyphon sp.	7	SC
	935	Cyphon americanus	7	
	936	Cyphon collaris	7	
	937	Cyphon modestus	7	
	938	Cyphon nebulosus	7	
	939	Cyphon obscurus	7	

	940	Cyphon punctatus	7	
	941	Cyphon perplexus	7	
	942	Scirtes sp.	7	SH
	943	Scirtes orbiculatus	7	
	944	Scirtes tibialis	7	
Family Haliplidae	945	Haliplidae	99.9	SH
	946	Haliplus sp.	99.9	MH
	947	Haliplus fasciatus	99.9	SH
	948	Haliplus immaculicollis	99.9	
	949	Haliplus leopardus	99.9	
	950	Haliplus pantherinus	99.9	
	951	Haliplus triopsis	99.9	
	952	Peltodytes sp.	99.9	SH
	953	Peltodytes duodecimpuntatus	99.9	
	954	Peltodytes dunavani	99.9	
	955	Peltodytes lengi	99.9	
	956	Peltodytes sexmaculatus	99.9	
Family Hydrophilidae	957	Hydrophilidae	99.9	PR
	958	Anacaena sp.	99.9	
	959	Anacaena limbata	99.9	
	960	Berosus sp.	99.9	PR
	961	Berosus fraternus	99.9	
	962	Berosus infuscatus	99.9	
	963	Berosus peregrinus	99.9	
	964	Berosus pugnax	99.9	
	965	Berosus striatus	99.9	CG
	966	Crenitis sp.	99.9	PR
	967	Cymbiodyta sp.	99.9	CG
	968	Cymbiodyta chamberlaini	99.9	
	969	Cymbiodyta semistriata	99.9	
	970	Cymbiodyta vindicata	99.9	
	971	Enochrus sp.	99.9	CG
	972	Enochrus cinctus	99.9	
	973	Enochrus consortus	99.9	
	974	Enochrus hamiltoni	99.9	
	975	Enochrus ochraceus	99.9	
	976	Enochrus perplexus	99.9	
	977	Enochrus pygmaeus	99.9	
	978	Enochrus sayi	99.9	
	979	Helocombus sp.	99.9	
	980	Helophorus sp.	99.9	SH
	981	Hydrobius sp.	99.9	PR
	982	Hydrobius fuscipes	99.9	
	983	Hydrochara sp.	99.9	CG
	984	Hydrochus sp.	99.9	SH
	985	Hydrophilus sp.	99.9	PR
	986	Laccobius sp.	99.9	PR
	987	Laccobius agilis	99.9	
	988	Laccobius minutoides	99.9	
	989	Paracymus sp.	99.9	PR

	990	Paracymus subcupreus	99.9	
	991	Tropisternus sp.	99.9	PR
	992	Tropisternus blatchleyi	99.9	
	993	Tropisternus lateralis	99.9	CG
	994	Tropisternus mixtus	99.9	
	995	Tropisternus natator	99.9	
Family Dytiscidae	996	Dytiscidae	99.9	PR
	997	Acilius sp.	99.9	PR
	998	Acilius fraternus	99.9	
	999	Acilius semisulcatus	99.9	
	1000	Agabetes sp.	99.9	PR
	1001	Agabus sp.	99.9	PR
	1002	Agabus ambiguus	99.9	
	1003	Agabus disintegratus	99.9	
	1004	Bidessonotus sp.	99.9	PR
	1005	Bidessonotus inconspicuus	99.9	
	1006	Celina sp.	99.9	PR
	1007	Celina hubbelli	99.9	
	1008	Copelatus sp.	99.9	PR
	1009	Copelatus chevrolati	99.9	
	1010	Copelatus glyphicus	99.9	
	1011	Coptotomus sp.	99.9	PR
	1012	Cybister sp.	99.9	PR
	1013	Cybister fimbriolatus	99.9	
	1014	Deronectes sp.	99.9	PR
	1015	Dytiscus sp.	99.9	PR
	1016	Dytiscus hybridus	99.9	
	1017	Hydaticus sp.	99.9	PR
	1018	Hydaticus modestus	99.9	
	1019	Hydroporus sp.	99.9	PR
	1020	Hydroporus clypealis	99.9	
	1021	Hydroporus consimilus	99.9	
	1022	Hydroporus niger	99.9	
	1023	Hydroporus rufilabris	99.9	
	1024	Hydroporus vittatipennis	99.9	
	1025	Hydrovatus sp.	99.9	PR
	1026	Hydrovatus pustulatus	99.9	PR
	1027	Hygrotus sp.	99.9	PR
	1028	Ilybius sp.	99.9	PR
	1029	Ilybius biguttulus	99.9	
	1030	Laccophilus sp.	99.9	PR
	1031	Laccophilus fasciatus	99.9	PR
	1032	Laccophilus maculosus	99.9	
	1033	Laccophilus proximus	99.9	PR
	1034	Laccornis sp.	99.9	PR
	1035	Liodessus sp.	99.9	PR
	1036	Matus sp.	99.9	PR
	1037	Matus bicarinatus	99.9	
	1038	Rhantus sp.	99.9	PR
	1039	Rhantus binotatus	99.9	

	1040	Thermonectus sp.	99.9	PR
	1041	Thermonectus basillaris	99.9	PR
	1042	Thermonectus ornaticollis	99.9	
	1043	Uvarus sp.	99.9	PR
Family Psephenidae	1044	Dicranopselaphus	4	SC
	1045	Ectopria sp.	4	SC
	1046	Ectopria nervosa	4	SC
	1047	Ectopria thoracica	4	
Family Dryopidae	1048	Dryopidae	4	SH
	1049	Helichus sp.	4	SH
	1050	Helichus fastigiatus	4	
	1051	Helichus lithophilus	4	
	1052	Helichus striatus	4	
	1053	Pelonomus sp.	4	CG
	1054	Pelonomus obscurus	4	
Family Elmidae	1055	Elmidae	5	CG
	1056	Ancyronyx sp.	2	
	1057	Ancyronyx variegata	2	CG
	1058	Dubiraphia sp.	5	CG
	1059	Dubiraphia bivittata	2	
	1060	Dubiraphia minima	5	
	1061	Dubiraphia quadrinotata	7	
	1062	Dubiraphia vittata	7	
	1063	Macronychus sp.	2	
	1064	Macronychus glabratus	2	
	1065	Microcylloepus sp.	2	CG
	1066	Microcylloepus pusillus	2	CG
	1067	Optioservus sp.	4	SC
	1068	Optioservus fastiditus	4	SC
	1069	Optioservus ovalis	4	SC
	1070	Optioservus trivittatus	4	SC
	1071	Promoresia sp.	5	SC
	1072	Stenelmis sp.	7	SC
	1073	Stenelmis bicarinata	7	SC
	1074	Stenelmis crenata	7	
	1075	Stenelmis decorata	7	SC
	1076	Stenelmis lateralis	7	SC
	1077	Stenelmis markeli	7	SC
	1078	Stenelmis mera	7	SC
	1079	Stenelmis musgravei	7	SC
	1080	Stenelmis sexlineata	7	SC
	1081	Stenelmis vittipennis	6	
Family Curculionidae	1082	Curculionidae	99.9	SH
	1083	Listronotus sp.	99.9	CF
Family Scirtidae	1084	Elodes	7	
	1085	Prionocyphon sp.	7	SC
Order Diptera	1086	Diptera	10	
Family Blephariceridae	1087	Blephariceridae	0	SC
	1088	Blepharicera sp.	0	SC
Family Tipulidae	1089	Tipulidae	4	SH

	1090	Tipula sp.	4	SH
	1091	Antocha sp.	5	CG
	1092	Dicranota sp.	4	PR
	1093	Eriocera sp.	7	PR
	1094	Erioptera sp.	4	CG
	1095	Gonomyia sp.	4	CG
	1096	Helius sp.	5	CG
	1097	Hesperoconopa sp.	2	CG
	1098	Hexatoma sp.	4	PR
	1099	Limnophila sp.	4	PR
	1100	Limonia sp.	3	SH
	1101	Ormosia sp.	4	CG
	1102	Pedicia sp.	4	PR
	1103	Pilaria sp.	4	PR
	1104	Prionocera sp.	4	SH
	1105	Pseudolimnophila sp.	2	PR
Family Chaoboridae	1106	Chaoboridae	8	PR
	1107	Chaoborus sp.	8	PR
	1108	Corethrella sp.	8	PR
Family Culicidae	1109	Culicidae	8	CG
	1110	Aedes sp.	8	CF
	1111	Aedes atropalpus	8	
	1112	Aedes canadensis	8	
	1113	Aedes cinereus	8	
	1114	Aedes communis	8	
	1115	Aedes dorsalis	8	
	1116	Aedes flavescens	8	
	1117	Aedes sollicitans	8	
	1118	Aedes sticticus	8	
	1119	Aedes stimulans	8	
	1120	Aedes triseriatus	8	
	1121	Aedes trivittatus	8	
	1122	Aedes vexans	8	
	1123	Anopheles sp.	6	CF
	1124	Anopheles barberi	6	
	1125	Anopheles crucians	6	
	1126	Anopheles earlei	6	
	1127	Anopheles punctipennis	6	
	1128	Anopheles quadrimaculatus	6	
	1129	Anopheles walkeri	6	
	1130	Culex sp.	8	CF
	1131	Culex erraticus	8	
	1132	Culex peccator	8	
	1133	Culex pipiens	8	CF
	1134	Culex quinquefasciatus	8	
	1135	Culex restuans	8	
	1136	Culex salinarius	8	
	1137	Culex tarsalis	8	
	1138	Culiseta sp.	8	CG
	1139	Culiseta inornata	8	

	1140	Culiseta melanura	8	
	1141	Mansonia sp.	8	CG
	1142	Mansonia perturbans	8	
	1143	Psorophora sp.	8	PR
	1144	Psorophora ciliata	8	
	1145	Psorophora confinnis	8	PR
	1146	Psorophora cyanescens	8	
	1147	Psorophora discolor	8	
	1148	Psorophora ferox	8	
	1149	Psorophora horrida	8	
	1150	Psorophora howardi	8	
	1151	Psorophora varipes	8	
	1152	Uranotaenia sp.	8	CF
	1153	Uranotaenia sapphirina	8	
Family Dixidae	1154	Dixidae	10	CG
	1155	Dixa sp.	10	CG
	1156	Dixella sp.	10	
Family Psychodidae	1157	Psychodidae	11	CG
	1158	Telmatoscopus sp.	11	CG
	1159	Pericoma sp.	11	CG
	1160	Psychoda sp.	11	CG
Family Ceratopogonidae	1161	Ceratopogonidae	5	PR
	1162	Atrichopogon sp.	2	PR
	1163	Bezzia sp.	5	CG
	1164	Ceratopogon sp.	5	PR
	1165	Culicoides sp.	5	PR
	1166	Dasyhelea sp.	5	CG
	1167	Forcipomyia sp.	5	SC
	1168	Monohelea sp.	5	PR
	1169	Nilobezzia sp.	5	PR
	1170	Palpomyia sp.	6	PR
	1171	Probezzia sp.	5	PR
	1172	Sphaeromias sp.	5	
	1173	Stilbezzia sp.	5	
Family Simuliidae	1174	Simuliidae	6	CF
	1175	Cnephia sp.	4	CF
	1176	Cnephia pecuarum	4	
	1177	Prosimulium sp.	2	CF
	1178	Prosimulium magnum	2	
	1179	Prosimulium mixtum	2	
	1180	Simulium sp.	6	CF
	1181	Simulium clarkei	4	
	1182	Simulium corbis	0	
	1183	Simulium decorum	4	CF
	1184	Simulium jenningsi	4	CF
	1185	Simulium luggeri	2	
	1186	Simulium meridionale	1	CF
	1187	Simulium tuberosum	4	CF
	1188	Simulium venustum	6	CF
	1189	Simulium verecundum	6	

	1190	Simulium vittatum	8	CF
Family Chironomidae	1191	Chironomidae	6	CG
	1192	Tanypodinae sp.	6	PR
	1193	Ablabesmyia sp.	6	CG
	1194	Ablabesmyia annulata	6	
	1195	Ablabesmyia hauberi	6	
	1196	Ablabesmyia janta	6	
	1197	Ablabesmyia janta var ii	6	
	1198	Ablabesmyia mallochi	6	
	1199	Ablabesmyia monilis	6	PR
	1200	Ablabesmyia parajanta	6	
	1201	Ablabesmyia peleenses	6	
	1202	Ablabesmyia tarella	6	
	1203	Clinotanypus sp.	6	PR
	1204	Clinotanypus pinguis	6	PR
	1205	Coelotanypus sp.	4	PR
	1206	Coelotanypus concinnus	6	PR
	1207	Conchapelopia sp.	6	PR
	1208	Djalmabatista sp.	6	PR
	1209	Djalmabatista pulchra	6	
	1210	Guttipelopia sp.	6	PR
	1211	Hayesomyia sp.	5	
	1212	Helopelopia sp.	4	PR
	1213	Hudsonimyia sp.	6	
	1214	Labrundinia sp.	4	PR
	1215	Labrundia neopilosella	4	
	1216	Labrundia pilosella	4	
	1217	Labrundinia virescens	6	PR
	1218	Larsia sp.	6	PR
	1219	Macropelopia sp.	7	PR
	1220	Meropelopia sp.	3	
	1221	Natarsia sp.	6	PR
	1222	Nilotanypus sp.	6	PR
	1223	Nilotanypus fimbriatus	6	PR
	1224	Paramerina sp.	6	PR
	1225	Pentaneura sp.	3	PR
	1226	Procladius sp.	8	PR
	1227	Psectrotanypus sp.	8	PR
	1228	Rheopelopia sp.	3	PR
	1229	Tanypus sp.	8	PR
	1230	Tanypus carinatus	8	
	1231	Tanypus neopunctipennis	8	
	1232	Tanypus punctipennis	8	
	1233	Tanypus stellatus	8	
	1234	Thienemannimyia sp.	6	PR
	1235	Thienemannimyia senata	6	
	1236	Zavrelimyia sp.	8	PR
	1237	Zavrelimyia sinuosa com	8	
	1238	Diamesinae sp.	6	
	1239	Diamesa sp.	4	CG

	1240	Odontomesa sp.	6	CG
	1241	Potthastia sp.	6	
	1242	Prodiamesa sp.	3	CG
	1243	Pseudodiamesa sp.	1	CG
	1244	Sympotthastia sp.	6	CG
	1245	Syndiamesa sp.	6	CG
	1246	Orthocladiinae sp.	6	CG
	1247	Orthocladius/cricotopus sp.	6	
	1248	Brillia sp.	6	SH
	1249	Cardiocladius sp.	6	PR
	1250	Chaetocladius sp.	6	CG
	1251	Corynoneura sp.	2	CG
	1252	Corynoneura taris	2	CG
	1253	Cricotopus sp.	8	SH
	1254	Cricotopus bicinctus	10	
	1255	Cricotopus intersectus	8	SH
	1256	Cricotopus sylvestris	8	
	1257	Cricotopus trifascia	6	
	1258	Epoicocladius sp.	6	CG
	1259	Eukiefferiella sp.	4	CG
	1260	Heterotrissocladius sp.	6	CG
	1261	Hydrobaenus sp.	2	SC
	1262	Gymnometriocnemus sp.	6	
	1263	Metriocnemus sp.	6	CG
	1264	Nanocladius sp.	3	CG
	1265	Nanocladius distinctus	3	CG
	1266	Orthocladius sp.	4	CG
	1267	Parakiefferiella sp.	5	
	1268	Parametriocnemus sp.	4	CG
	1269	Paraphaenocladius sp.	6	CG
	1270	Psectrocladius sp.	5	CG
	1271	Pseudorthocladius sp.	6	CG
	1272	Rheocricotopus sp.	6	CG
	1273	Rheocricotopus fuscipes	6	
	1274	Rheocricotopus robacki	6	
	1275	Smittia sp.	6	CG
	1276	Stilocladius sp.	6	
	1277	Tvetenia sp.	5	
	1278	Thienemanniella sp.	2	CG
	1279	Thienemanniella xena	2	CG
	1280	Zalutschia sp.	6	SH
	1281	Chironomini sp.	6	CG
	1282	Axarus sp.	6	CG
	1283	Chironomus sp.	11	CG
	1284	Chironomus anthracinus	11	
	1285	Zylotopus par	6	
	1286	Chironomus attenuatus	10	
	1287	Chironomus decorus	11	
	1288	Chironomus plumosus	11	
	1289	Chironomus riparius	11	

	1290	Chironomus staegeri	11	
	1291	Cladopelma sp.	6	CG
	1292	Cryptochironomus sp.	8	PR
	1293	Cryptochironomus digitatus	8	
	1294	Cryptochironomus fulvus	8	PR
	1295	Cryptotendipes sp.	6	CG
	1296	Demicryptochironomus sp.	6	CG
	1297	Dicrotendipes sp.	6	CG
	1298	Dicrotendipes lucifer	6	
	1299	Dicrotendipes modestus	6	CG
	1300	Dicrotendipes neomodestus	6	CG
	1301	Dicrotendipes nervosus	6	
	1302	Dicrotendipes simpsoni	6	
	1303	Dicrotendipes tritomus	6	
	1304	Einfeldia sp.	10	CG
	1305	Einfeldia austeni	10	
	1306	Einfeldia pagana	10	
	1307	Endochironomus sp.	6	SH
	1308	Endochironomus nigricans	6	SH
	1309	Endochironomus subtendens	6	SH
	1310	Glyptotendipes sp.	10	CF
	1311	Glyptotendipes lobiferus	10	SH
	1312	Glyptotendipes papipes	10	
	1313	Harnischia sp.	6	CG
	1314	Kiefferulus sp.	7	CG
	1315	Lipiniella sp.	6	
	1316	Microchironomus sp.	6	CG
	1317	Microtendipes sp.	6	CF
	1318	Microtendipes caducus	6	
	1319	Microtendipes pedellus	6	CF
	1320	Nilothauma sp.	3	
	1321	Parachironomus sp.	8	PR
	1322	Parachironomus carinatus	8	PR
	1323	Parachironomus directus	8	
	1324	Parachironomus frequens	8	
	1325	Parachironomus monochromus	8	
	1326	Parachironomus pectinatella	4	
	1327	Parachironomus tenuicaudatus	8	
	1328	Paracladopelma sp.	4	CG
	1329	Paralauterborniella sp.	6	CG
	1330	Paralauterborniella nigrohalteralis	6	
	1331	Paratendipes sp.	3	CG
	1332	Pagastiella sp.	6	
	1333	Paratendipes albimanus	3	
	1334	Phaenopsectra sp.	4	SC
	1335	Phaenopsectra flavipes	4	SC
	1336	Phaenopsectra obediens gr	4	
	1337	Phaenopsectra punctipes gr	4	
	1338	Polypedilum sp.	6	SH
	1339	Polypedilum convictum	6	SH

	1340	Polypedilum obtusum	6	SH
	1341	Polypedilum fallax	6	SH
	1342	Polypedilum halterale	4	SH
	1343	Polypedilum illinoense	5	SH
	1344	Polypedilum scalaenum	6	SH
	1345	Polypedilum simulans	6	SH
	1346	Polypedilum digitifer	6	SH
	1347	Pseudochironomus sp.	5	CG
	1348	Pseudochironomus fulviventris	5	
	1349	Pseudochironomus prasinatus	5	
	1350	Robackia sp.	3	CG
	1351	Saetheria sp.	6	CG
	1352	Seatheria tylus	4	
	1353	Stenochironomus sp.	3	SH
	1354	Stenochironomus hilaris	3	CG
	1355	Stelechomyia	6	CG
	1356	Stelechomyia pulpulchra	6	CG
	1357	Stictochironomus sp.	5	
	1358	Stictochironomus caffrarius	5	
	1359	Stictochironomus devinctus	5	
	1360	Tribelos sp.	5	CG
	1361	Tribelos fuscicorne	4	CG
	1362	Tribelos jucundus	5	
	1363	Xenochironomus sp.	4	PR
	1364	Xenochironomus xenolabis	6	
	1365	Xestochironomus sp.	6	
	1366	Tanytarsini sp.	6	CF
	1367	Cladotanytarsus sp.	7	CG
	1368	Cladotanytarsus daviese	7	
	1369	Cladotanytarsus species a	7	
	1370	Cladotanytarsus species b	7	
	1371	Cladotanytarsus species c	7	
	1372	Cladotanytarsus species f	7	
	1373	Cladotanytarsus species h	7	
	1374	Micropsectra sp.	4	CG
	1375	Paratanytarsus sp.	6	CG
	1376	Rheotanytarsus sp.	6	CF
	1377	Stempellina sp.	2	CG
	1378	Stempellinella sp.	2	CG
	1379	Sublettea sp.	6	CF
	1380	Tanytarsus sp.	7	CF
	1381	Tanytarsus guerlus	7	
	1382	Tanytarsus glabrescan	7	
Family Ptychopteridae	1383	Ptychopteridae	8	CG
	1384	Bittacomorpha sp.	8	CG
	1385	Ptychoptera sp.	8	CG
Family Stratiomyidae	1386	Stratiomyidae	10	CG
	1387	Odostomia sp.	10	CG
	1388	Odostomia cincta	10	
	1389	Oxycera sp.	10	SC

	1390	Stratiomys sp.	10	CF
	1391	Stratiomys discalis	10	
	1392	Stratiomys meigeni	10	
Family Tabanidae	1393	Tabanidae	7	PR
	1394	Atylotus sp.	7	PR
	1395	Atylotus bicolor	7	
	1396	Chlorotabanus sp.	7	
	1397	Chrysops sp.	7	CG
	1398	Chrysops aberrans	7	
	1399	Chrysops brunneus	7	
	1400	Chrysops callidus	7	
	1401	Chrysops cincticornus	7	
	1402	Chrysops dimmocki	7	
	1403	Chrysops flavidus	7	
	1404	Chrysops geminatus	7	
	1405	Chrysops macquarti	7	
	1406	Chrysops moechus	7	
	1407	Chrysops montanus	7	
	1408	Chrysops niger	7	
	1409	Chrysops striatus	7	
	1410	Chrysops univittatus	7	
	1411	Chrysops vittatus	7	
	1412	Hybomitra sp.	7	PR
	1413	Tabanus sp.	7	PR
	1414	Tabanus atratus	7	
	1415	Tabanus cymatophorus	7	
	1416	Tabanus fairchildi	7	
	1417	Tabanus lineola	7	
	1418	Tabanus marginalis	7	
	1419	Tabanus nigrescens	7	
	1420	Tabanus pumilus	7	
	1421	Tabanus quinquevittatus	7	
	1422	Tabanus reinwardtii	7	
	1423	Tabanus sparus	7	
	1424	Tabanus stygius	7	
	1425	Tabanus subsimilis	7	
	1426	Tabanus sulcifrons	7	
	1427	Tabanus superjumentarius	7	
	1428	Tabanus trimaculatus	7	
Family Dolichopodidae	1429	Dolichopodidae	5	PR
	1430	Hydrophorus sp.	99.9	PR
Family Empididae	1431	Empididae	6	PR
	1432	Hemerodromia sp.	6	PR
Family Syrphidae	1433	Syrphidae	11	CG
	1434	Chrysogaster sp.	11	CG
	1435	Eristalis sp.	11	CG
Family Ephydridae	1436	Ephydridae	8	CG
	1437	Ephydra sp.	8	CG
Family Sciomyzidae	1438	Sciomyzidae	10	PR
	1439	Dictya sp.	10	PR

	1440	Dictya pictipes	10	
Family Muscidae	1441	Muscidae	8	PR
	1442	Limnophora sp.	8	PR
Family Athericidae	1443	Athericidae	10	
	1444	Atherix sp.	10	PR
	1445	Atherix variegata	4	PR
Phylum Mollusca	1446	Mollusca	99.9	
Class Gastropoda	1447	Gastropoda	99.9	SC
Order Mesogastropoda	1448	Mesogastropoda	6	SC
Family Viviparidae	1449	Viviparidae	6	SC
	1450	Campeloma sp.	7	SC
	1451	Lioplax sp.	7	SC
	1452	Viviparus sp.	1	SC
	1453	Valvatidae sp.	6	SC
	1454	Valvata sp.	2	SC
Family Bithyniidae	1455	Bithyniidae	6	
	1456	Bithynia sp.	6	
Family Hydrobiidae	1457	Hydrobiidae	6	SC
	1458	Amnicola sp.	4	SC
	1459	Amnicola walkeri	4	
	1460	Cincinnatia sp.	6	SC
	1461	Marstonia sp.	6	
	1462	Probythinella sp.	6	
	1463	Pyrgulopsis sp.	6	SC
	1464	Somatogyrus sp.	6	
Family Pleuroceridae	1465	Pleuroceridae	6	
	1466	Elimia sp.	6	SC
	1467	Goniobasis sp.	5	SC
	1468	Leptoxis sp.	6	
	1469	Lithasia sp.	6	
	1470	Pleurocera sp.	7	SC
	1471	Pleurocera acuta	7	SC
Family Pomatiopsidae	1472	Pomatiopsidae	6	
	1473	Pomatiopsis sp.	6	
Order Basommatophora	1474	Basommatophora	9	SC
Family Physidae	1475	Physidae	9	SC
	1476	Aplexa sp.	7	
	1477	Physa sp.	9	SC
	1478	Physa acuta	9	
	1479	Physa integra	9	CG
	1480	Physella sp.	9	SC
	1481	Physella sayi	9	
Family Lymnaeidae	1482	Lymnaeidae	7	SC
	1483	Acella sp.	7	
	1484	Lymnaea sp.	7	SC
	1485	Fossaria sp.	7	SC
	1486	Fossaria obrussa	7	
	1487	Pseudosuccinea sp.	7	SC
	1488	Pseudosuccinea columella	7	SC
	1489	Stagnicola sp.	7	SC

	1490	Stagnicola emarginatus	7	
Family Planorbidae	1491	Planorbidae	6.5	SC
	1492	Gyraulus sp.	6	SC
	1493	Helisoma sp.	7	SC
	1494	Menetus sp.	6.5	SC
	1495	Planorbella sp.	6.5	SC
	1496	Planorbella truncata	6.5	
	1497	Planorbula sp.	7	SC
	1498	Promenetus sp.	6.5	CG
Family Ancylidae	1499	Ancylidae	7	SC
	1500	Ferrissia sp.	7	SC
	1501	Ferrissia rivularis	7	SC
	1502	Laevapex sp.	6	SC
	1503	Laevapex fuscus	6	SC
	1504	Laevapex diaphanus	6	SC
Class Pelecypoda	1505	Pelecypoda	99.9	CF
Order Unionoida	1506	Unionoida	1.5	
Family Unionidae	1507	Unionidae	1.5	CF
	1508	Actinonaias sp.	1.5	
	1509	Actinonaias carinata	1	
	1510	Actinonaias ellipsiformis	1.5	
	1511	Actinonaias ligamentina	1.5	
	1512	Alasmidonta sp.	1.5	CF
	1513	Alasmidonta calceolus	1.5	
	1514	Alasmidonta marginata	1	
	1515	Alasmidonta triangulata	1.5	
	1516	Amblema sp.	1.5	
	1517	Amblema plicata	1.5	
	1518	Anodonta sp.	3	CF
	1519	Anodonta grandis	3	
	1520	Anodonta imbecilis	3	
	1521	Anodonta suborbiculata	3	
	1522	Anodontoides sp.	1.5	CF
	1523	Anodontoides ferussacianus	1.5	
	1524	Arcidens sp.	1.5	CF
	1525	Arcidens confragosus	1.5	
	1526	Carunculina sp.	7	CF
	1527	Toxolasma paruvus	7	
	1528	Carunculina parva	7	
	1529	Toxolasma texasensis	7	
	1530	Cyclonaias sp.	1.5	
	1531	Cyclonaias tuberculata	1.5	
	1532	Cyprogenia sp.	1.5	
	1533	Cyprogenia irrorata	1.5	
	1534	Dysnomia sp.	1.5	
	1535	Dysnomia triquetra	1.5	
	1536	Elliptio sp.	2	CF
	1537	Elliptio crassidens	2	
	1538	Elliptio dilatata	2	
	1539	Fusconaia sp.	1	

	1540	Fusconaia ebena	1	
	1541	Fusconaia flava	1	
	1542	Lampsilis sp.	1	CF
	1543	Lampsilis teres	1	CF
	1544	Lampsilis fasciola	1	
	1545	Lampsilis radiata	1	
	1546	Lampsilis ventricosa	1	
	1547	Lampsilis orbiculata	1	
	1548	Lampsilis higginsi	1	
	1549	Lasmigona sp.	1.5	
	1550	Lasmigona complanata	1.5	
	1551	Lasmigona compressa	1.5	
	1552	Lasmigona costata	1.5	
	1553	Leptodea sp.	1.5	CF
	1554	Leptodea fragilis	1.5	
	1555	Ligumia sp.	1	CF
	1556	Ligumia recta	1	
	1557	Ligumia subrostrata	1	
	1558	Megalonaias sp.	1.5	
	1559	Megalonaias nervosa	1.5	
	1560	Obliquaria sp.	1	
	1561	Obliquaria reflexa	1	
	1562	Obovaria sp.	1.5	
	1563	Obovaria olivaria	1.5	
	1564	Obovaria subrotunda	1.5	
	1565	Plagiola lineolata	1.5	
	1566	Plethobasus sp.	1.5	
	1567	Plethobasus cyphyus	1.5	
	1568	Pleurobema sp.	1.5	
	1569	Pleurobema cordatum	1.5	
	1570	Proptera sp.	1	
	1571	Proptera alata	1	
	1572	Proptera capax	1	
	1573	Proptera laevissimus	1	
	1574	Ptychobranchus sp.	1.5	
	1575	Ptychobranchus fasciolaris	1.5	
	1576	Quadrula sp.	1.5	
	1577	Quadrula cyclindrica	1.5	
	1578	Quadrula metanerva	1.5	
	1579	Quadrula nodulata	1.5	
	1580	Quadrula pustulosa	1.5	
	1581	Quadrula quadrula	1.5	
	1582	Strophitus sp.	4	
	1583	Strophitus undulatus	4	
	1584	Tritogonia sp.	1	
	1585	Tritogonia verrucosa	1	
	1586	Truncilla sp.	1	
	1587	Truncilla donaciformis	1	
	1588	Truncilla truncata	1	
	1589	Uniomerus sp.	1.5	

	1590	Uniomerus tetralasmus	1.5	
	1591	Villosa sp.	1	
	1592	Villosa iris	1	
	1593	Villosa lienosa	1	
Order Venerioda	1594	Venerioda	5	
Family Pisidiidae	1595	Pisidiidae	5	
Family Sphaeriidae	1596	Sphaeriidae	5	
	1597	Musculium sp.	5	CF
	1598	Musculium transversum	5	CF
	1599	Pisidium sp.	5	CF
	1600	Sphaerium sp.	5	CG
Family Corbiculidae	1601	Corbicula	4	CF
Family Dreissenidae	1602	Dreissena polymorpha	99.9	

Appendix G-2
Alphabetical Order

Bios ID	Taxon	Tolerance	Functional Feeding Group
1194	Ablabesmyia annulata	6	
1195	Ablabesmyia hauberi	6	
1196	Ablabesmyia janta	6	
1197	Ablabesmyia janta var ii	6	
1198	Ablabesmyia mallochi	6	
1199	Ablabesmyia monilis	6	PR
1200	Ablabesmyia parajanta	6	
1201	Ablabesmyia peleenses	6	
1193	Ablabesmyia sp.	6	CG
1202	Ablabesmyia tarella	6	
225	Acanthametropus pecatonica	3	
224	Acanthametropus sp.	3	PR
1483	Acella sp.	7	
244	Acentrella sp.	4	
259	Acerpenna pygmaeus	4	
245	Acerpenna sp.	4	SH
998	Acilius fraternus	99.9	
999	Acilius semisulcatus	99.9	
997	Acilius sp.	99.9	PR
596	Acroneuria abnormis	1	PR
597	Acroneuria arida	1	PR
598	Acroneuria carolinensis	1	PR
599	Acroneuria evoluta	1	PR
600	Acroneuria internata	1	PR
601	Acroneuria lycorias	1	PR
595	Acroneuria sp.	1	PR
94	Actinobdella inequiannulata	8	
93	Actinobdella sp.	8	
1509	Actinonaias carinata	1	
1510	Actinonaias ellipsiformis	1.5	
1511	Actinonaias ligamentina	1.5	
1508	Actinonaias sp.	1.5	
1111	Aedes atropalpus	8	
1112	Aedes canadensis	8	
1113	Aedes cinereus	8	
1114	Aedes communis	8	
1115	Aedes dorsalis	8	
1116	Aedes flavescens	8	
1117	Aedes sollicitans	8	
1110	Aedes sp.	8	CF
1118	Aedes sticticus	8	
1119	Aedes stimulans	8	
1120	Aedes triseriatus	8	
1121	Aedes trivittatus	8	
1122	Aedes vexans	8	
17	Aeolosomatidae	10	CF

437	Aeschna canadensis	4	
438	Aeschna constricta	4	PR
436	Aeschna sp.	4	PR
439	Aeschna umbrosa	4	
440	Aeschna verticalis	4	
435	Aeshnidae	4.5	PR
1000	Agabetes sp.	99.9	PR
1002	Agabus ambiguus	99.9	
1003	Agabus disintegratus	99.9	
1001	Agabus sp.	99.9	PR
801	Agapetus illini	2	
800	Agapetus sp.	2	SC
914	Agarodes distincta	3.5	
807	Agraylea multipunctata	2	
806	Agraylea sp.	2	PH
868	Agrypnia sp.	3	SH
869	Agrypnia vestita	3	
1513	Alasmidonta calceolus	1.5	
1514	Alasmidonta marginata	1	
1512	Alasmidonta sp.	1.5	CF
1515	Alasmidonta triangulata	1.5	
96	Alboglossiphonia heteroclita	8	PR
95	Alboglossiphonia sp.	8	
586	Allocapnia mystica	1.5	
587	Allocapnia recta	1.5	
585	Allocapnia sp.	2	SH
588	Allocapnia vivipara	1.5	SH
23	Allonais pectinata	10	
22	Allonais sp.	10	CG
632	Alloperla sp.	1.5	PR
1517	Amblema plicata	1.5	
1516	Amblema sp.	1.5	
227	Ameletus lineatus	0	
226	Ameletus sp.	0	CG
1458	Amnicola sp.	4	SC
1459	Amnicola walkeri	4	
536	Amphiagrion saucium	5	
535	Amphiagrion sp.	5	PR
25	Amphichaeta leydigi	10	
24	Amphichaeta sp.	10	CG
577	Amphinemura sp.	1.5	SH
172	Amphipoda	4	CG
839	Anabolia sp.	3.5	SH
959	Anacaena limbata	99.9	
958	Anacaena sp.	99.9	
442	Anax junius	5	PR
441	Anax sp.	5	PR
1499	Ancylidae	7	SC
1056	Ancyronyx sp.	2	
1057	Ancyronyx variegata	2	CG
288	Anepeorus simplex	3.5	
287	Anepeorus sp.	3.5	PR
10	Annelida	99.9	CG

1519	Anodonta grandis	3	
1520	Anodonta imbecilis	3	
1518	Anodonta sp.	3	CF
1521	Anodonta suborbiculata	3	
1523	Anodontoides ferussacianus	1.5	
1522	Anodontoides sp.	1.5	CF
538	Anomalagrion hastatum	5.5	PR
537	Anomalagrion sp.	5.5	PR
1124	Anopheles barberi	6	
1125	Anopheles crucians	6	
1126	Anopheles earlei	6	
1127	Anopheles punctipennis	6	
1128	Anopheles quadrimaculatus	6	
1123	Anopheles sp.	6	CF
1129	Anopheles walkeri	6	
377	Anthopotamus sp.	4	
1091	Antocha sp.	5	CG
1476	Aplexa sp.	7	
526	Archilestes grandis	1	
525	Archilestes sp.	1	PR
1525	Arcidens confragosus	1.5	
1524	Arcidens sp.	1.5	CF
27	Arcteonais lomondi	10	CG
26	Arcteonais sp.	10	
540	Argia apicalis	5	PR
541	Argia bipunctulata	5	
542	Argia moesta	5	PR
543	Argia sedula	5	PR
539	Argia sp.	5	PR
544	Argia tibialis	5	PR
545	Argia translata	5	
546	Argia violacea	5	PR
407	Arigomphus sp.	7	PR
290	Arthroplea bipunctata	3	
289	Arthroplea sp.	3	CF
150	Arthropoda	99.9	
153	Asellidae	6	CG
164	Asellus communis	6	
166	Asellus intermedius	6	
165	Asellus sp.	6	
1443	Athericidae	10	
1444	Atherix sp.	10	PR
1445	Atherix variegata	4	PR
609	Atoperla sp.	1	
1162	Atrichopogon sp.	2	PR
603	Attaneuria ruralis	1.5	PR
602	Attaneuria sp.	1.5	
325	Attenella attenuata	2	CG
324	Attenella sp.	2	CG
1395	Atylotus bicolor	7	
1394	Atylotus sp.	7	PR
76	Aulodrilus pigueti	10	CG
1282	Axarus sp.	6	CG

179	Bactrurus sp.	1	
243	Baetidae	4	CG
247	Baetis amplus	4	CG
248	Baetis armillatus	4	
249	Baetis brunneicolor	4	CG
250	Baetis ephippiatus	4	
251	Baetis flavistriga	4	CG
252	Baetis frondalis	4	
253	Baetis hageni	4	CG
254	Baetis intercalaris	7	
255	Baetis levitans	4	
256	Baetis longipalpus	6	
257	Baetis macdunnoughi	4	CG
258	Baetis propinquus	4	
260	Baetis quilleri	4	
246	Baetis sp.	4	CG
261	Baetis tricaudatus	1	CG
263	Baetis vagans	4	
360	Baetisca bajkovi	3	
362	Baetisca lacustris	3	
363	Baetisca laurentina	3	
364	Baetisca obesa	3	
361	Baetisca sp.	3	CG
359	Baetiscidae	3	CG
871	Banksiola crotchi	2	
870	Banksiola sp.	2	SH
262	Barbaetis cestus	4	
444	Basiaeschna janata	2	PR
443	Basiaeschna sp.	2	PR
1474	Basommatophora	9	SC
98	Batracobdella phalera	8	
99	Batracobdella picta	8	
97	Batracobdella sp.	8	PR
672	Belostoma flumineum	99.9	PR
671	Belostoma sp.	99.9	PR
670	Belostomatidae	99.9	PR
961	Berosus fraternus	99.9	
962	Berosus infuscatus	99.9	
963	Berosus peregrinus	99.9	
964	Berosus pugnax	99.9	
960	Berosus sp.	99.9	PR
965	Berosus striatus	99.9	CG
1163	Bezzia sp.	5	CG
1005	Bidessonotus inconspicuus	99.9	
1004	Bidessonotus sp.	99.9	PR
1456	Bithynia sp.	6	
1455	Bithyniidae	6	
1384	Bittacomorpha sp.	8	CG
1088	Blepharicera sp.	0	SC
1087	Blephariceridae	0	SC
445	Boyeria sp.	3	PR
446	Boyeria vinosa	3	PR
827	Brachycentridae	3.5	CF

829	Brachycentrus americanus	1	CF
830	Brachycentrus lateralis	1	CF
831	Brachycentrus numerosus	1	CF
832	Brachycentrus occidentalis	1	CF
828	Brachycentrus sp.	1	CF
357	Brachycercus sp.	3	CG
12	Branchiobdellida	10	PA
13	Branchiobdellidae	10	CG
78	Branchiura sowerbyi	10	CG
77	Branchiura sp.	10	CG
28	Bratislavia sp.	10	CG
29	Bratislavia unidentata	10	CG
1248	Brillia sp.	6	SH
655	Buenoa sp.	99.9	PR
155	Caecidotea brevicaudus	6	
156	Caecidotea communis	6	CG
157	Caecidotea forbesi	6	
158	Caecidotea intermedia	6	
159	Caecidotea kendeighi	6	
161	Caecidotea packardi	6	
154	Caecidotea sp.	6	CG
162	Caecidotea spatulata	6	
163	Caecidotea stygia	6	
160	Caecidotea tridentata	6	
356	Caenidae	5.5	CG
358	Caenis sp.	6	CG
265	Callibaetis ferrugineus	4	
266	Callibaetis fluctuans	4	
267	Callibaetis skokianus	4	
264	Callibaetis sp.	4	CG
517	Calopterygidae	3.5	PR
519	Calopteryx aequabilis	4	
520	Calopteryx maculata	4	PR
518	Calopteryx sp.	4	PR
193	Cambarellus puer	5	CG
194	Cambarellus shufeldtii	5	CG
192	Cambarellus sp.	5	SH
191	Cambaridae	5	CG
196	Cambarus diogenes	5	
197	Cambarus rusticiformis	5	
195	Cambarus sp.	5	CG
198	Cambarus tenebrosus	5	
1450	Campeloma sp.	7	SC
589	Capnia sp.	1	SH
590	Capnia vernalis	1	
584	Capniidae	1.5	SH
1249	Cardiocladius sp.	6	PR
1528	Carunculina parva	7	
1526	Carunculina sp.	7	CF
1007	Celina hubbelli	99.9	
1006	Celina sp.	99.9	PR
478	Celithemis elisa	2	
479	Celithemis eponina	2	

480	Celithemis monomelaena	2	
477	Celithemis sp.	2	PR
268	Centroptilum sp.	2	CG
883	Ceraclea ancylus	3	
884	Ceraclea cancellata	3	
885	Ceraclea diluta	3	
886	Ceraclea flava	3	
887	Ceraclea maculata	3	
888	Ceraclea nepha	3	
890	Ceraclea resurgens	3	
882	Ceraclea sp.	3	CG
889	Ceraclea transversa	3	
1164	Ceratopogon sp.	5	PR
1161	Ceratopogonidae	5	PR
749	Ceratopsyche alhedra	4	
763	Ceratopsyche alhedra	4	
735	Ceratopsyche alterans	4	
751	Ceratopsyche alternans	5	CF
738	Ceratopsyche bronta	4	CF
764	Ceratopsyche bronta	4	
736	Ceratopsyche cheilonis	4	
737	Ceratopsyche morosa	4	
744	Ceratopsyche morosa	4	
765	Ceratopsyche morosa	4	
766	Ceratopsyche slossonae	4	
762	Ceratopsyche sp.	4	CF
767	Ceratopsyche sparna	4	
1250	Chaetocladius sp.	6	CG
31	Chaetogaster diaphanus	10	PR
32	Chaetogaster diastrophus	10	PR
33	Chaetogaster limnaei	10	PR
30	Chaetogaster sp.	10	SH
1106	Chaoboridae	8	PR
1107	Chaoborus sp.	8	PR
711	Chauliodes pectinicornis	4	PR
712	Chauliodes rastricornis	4	PR
710	Chauliodes sp.	4	PR
726	Cheumatopsyche sp.	6	CF
770	Chimarra aterrima	3	CF
771	Chimarra feria	3	CF
772	Chimarra obscura	3	CF
773	Chimarra socia	3	CF
769	Chimarra sp.	3	CF
1191	Chironomidae	6	CG
1281	Chironomini sp.	6	CG
1284	Chironomus anthracinus	11	
1286	Chironomus attenuatus	10	
1287	Chironomus decorus	11	
1288	Chironomus plumosus	11	
1289	Chironomus riparius	11	
1283	Chironomus sp.	11	CG
1290	Chironomus staegeri	11	
631	Chloroperla sp.	3	

630	Chloroperlidae	1.5	PR
1396	Chlorotabanus sp.	7	
367	Choroterpes basalis	2	CG
366	Choroterpes sp.	2	CG
548	Chromagrion conditum	5.5	
547	Chromagrion sp.	5.5	PR
1434	Chrysogaster sp.	11	CG
1398	Chrysops aberrans	7	
1399	Chrysops brunneus	7	
1400	Chrysops callidus	7	
1401	Chrysops cincticornus	7	
1402	Chrysops dimmocki	7	
1403	Chrysops flavidus	7	
1404	Chrysops geminatus	7	
1405	Chrysops macquarti	7	
1406	Chrysops moechus	7	
1407	Chrysops montanus	7	
1408	Chrysops niger	7	
1397	Chrysops sp.	7	CG
1409	Chrysops striatus	7	
1410	Chrysops univittatus	7	
1411	Chrysops vittatus	7	
1460	Cincinnatia sp.	6	SC
1291	Cladopelma sp.	6	CG
1368	Cladotanytarsus daviese	7	
1367	Cladotanytarsus sp.	7	CG
1369	Cladotanytarsus species a	7	
1370	Cladotanytarsus species b	7	
1371	Cladotanytarsus species c	7	
1372	Cladotanytarsus species f	7	
1373	Cladotanytarsus species h	7	
721	Climacea areolaris	1	
720	Climacea sp.	1	
1204	Clinotanypus pinguis	6	PR
1203	Clinotanypus sp.	6	PR
271	Cloeon alamamce	3	
272	Cloeon rubropictum	3	
270	Cloeon sp.	3	
1176	Cnephia pecuarum	4	
1175	Cnephia sp.	4	CF
1206	Coelotanypus concinnus	6	PR
1205	Coelotanypus sp.	4	PR
549	Coenagrion sp.	5.5	PR
534	Coenagrionidae	5.5	PR
922	Coleoptera	99.9	PR
1207	Conchapelopia sp.	6	PR
1009	Copelatus chevrolati	99.9	
1010	Copelatus glyphicus	99.9	
1008	Copelatus sp.	99.9	PR
1011	Coptotomus sp.	99.9	PR
1601	Corbicula	4	CF
401	Cordulegaster maculata	2	PR
402	Cordulegaster obliqua	2	PR

400	Cordulegaster sp.	2	PR
399	Cordulegastridae	4.5	PR
461	Cordulia shurtleffi	2	
460	Cordulia sp.	2	PR
459	Corduliidae	4.5	PR
1108	Corethrella sp.	8	PR
677	Corixidae	99.9	PR
709	Corydalidae	3	PR
714	Corydalus cornutus	3	PR
713	Corydalus sp.	3	PR
1251	Corynoneura sp.	2	CG
1252	Corynoneura taris	2	CG
181	Crangonyx forbesi	4	CG
182	Crangonyx gracilis	4	CG
183	Crangonyx minor	4	
184	Crangonyx packardi	4	
185	Crangonyx pseudogracilis	4	
180	Crangonyx sp.	4	CG
966	Crenitis sp.	99.9	PR
1254	Cricotopus bicinctus	10	
1255	Cricotopus intersectus	8	SH
1253	Cricotopus sp.	8	SH
1256	Cricotopus sylvestris	8	
1257	Cricotopus trifascia	6	
151	Crustacea	99.9	CG
1293	Cryptochironomus digitatus	8	
1294	Cryptochironomus fulvus	8	PR
1292	Cryptochironomus sp.	8	PR
1295	Cryptotendipes sp.	6	CG
1131	Culex erraticus	8	
1132	Culex peccator	8	
1133	Culex pipiens	8	CF
1134	Culex quinquefasciatus	8	
1135	Culex restuans	8	
1136	Culex salinarius	8	
1130	Culex sp.	8	CF
1137	Culex tarsalis	8	
1109	Culicidae	8	CG
1165	Culicoides sp.	5	PR
1139	Culiseta inornata	8	
1140	Culiseta melanura	8	
1138	Culiseta sp.	8	CG
1082	Curculionidae	99.9	SH
1013	Cybister fimbriolatus	99.9	
1012	Cybister sp.	99.9	PR
1530	Cyclonaias sp.	1.5	
1531	Cyclonaias tuberculata	1.5	
968	Cymbiodyta chamberlaini	99.9	
969	Cymbiodyta semistriata	99.9	
967	Cymbiodyta sp.	99.9	CG
970	Cymbiodyta vindicata	99.9	
935	Cyphon americanus	7	
936	Cyphon collaris	7	

937	Cyphon modestus	7	
938	Cyphon nebulosus	7	
939	Cyphon obscurus	7	
941	Cyphon perplexus	7	
940	Cyphon punctatus	7	
934	Cyphon sp.	7	SC
1533	Cyprogenia irrorata	1.5	
1532	Cyprogenia sp.	1.5	
780	Cyrnellus fraternus	5	CF
779	Cyrnellus sp.	5	CF
121	Cystobranchus sp.	7	
120	Cystobranchus verrilli	7	
327	Dannella lita	2	CG
328	Dannella simplex	2	CG
326	Dannella sp.	2	
1166	Dasyhelea sp.	5	CG
190	Decapoda	99.9	SH
1296	Demicryptochironomus sp.	6	CG
35	Dero digitata	10	CG
36	Dero furcata	10	CG
37	Dero lodeni	10	CG
38	Dero nivea	10	CG
39	Dero pectinata	10	CG
34	Dero sp.	10	CG
1014	Deronectes sp.	99.9	PR
100	Desserobdella phalera	8	
1239	Diamesa sp.	4	CG
1238	Diamesinae sp.	6	
1044	Dicranopselaphus	4	SC
1092	Dicranota sp.	4	PR
1298	Dicrotendipes lucifer	6	
1299	Dicrotendipes modestus	6	CG
1300	Dicrotendipes neomodestus	6	CG
1301	Dicrotendipes nervosus	6	
1302	Dicrotendipes simpsoni	6	
1297	Dicrotendipes sp.	6	CG
1303	Dicrotendipes tritomus	6	
1440	Dictya pictipes	10	
1439	Dictya sp.	10	PR
452	Didymops sp.	4	PR
453	Didymops transversa	4	PR
141	Dina dubia	8	
142	Dina parva	8	
140	Dina sp.	8	PR
925	Dineutus assimilis	4	PR
926	Dineutus discolor	4	PR
924	Dineutus sp.	4	PR
728	Diplectrona metaqui	2	
729	Diplectrona modesta	2	CF
727	Diplectrona sp.	2	CF
1086	Diptera	10	
1155	Dixa sp.	10	CG
1156	Dixella sp.	10	

1154	Dixidae	10	CG
1209	Djalmabatista pulchra	6	
1208	Djalmabatista sp.	6	PR
1429	Dolichopodidae	5	PR
775	Dolophilodes distinctus	0	
774	Dolophilodes sp.	0	CG
1602	Dreissena polymorpha	99.9	
405	Dromogomphus sp.	4	PR
406	Dromogomphus spinosus	4	PR
331	Drunella cornutella	1	SC
329	Drunella sp.	1	PR
1048	Dryopidae	4	SH
1059	Dubiraphia bivittata	2	
1060	Dubiraphia minima	5	
1061	Dubiraphia quadrinotata	7	
1058	Dubiraphia sp.	5	CG
1062	Dubiraphia vittata	7	
5	Dugesia sp.	6	
6	Dugesia tigrina	6	PR
1534	Dysnomia sp.	1.5	
1535	Dysnomia triquetra	1.5	
996	Dytiscidae	99.9	PR
1016	Dytiscus hybridus	99.9	
1015	Dytiscus sp.	99.9	PR
1046	Ectopria nervosa	4	SC
1045	Ectopria sp.	4	SC
1047	Ectopria thoracica	4	
1305	Einfeldia austeni	10	
1306	Einfeldia pagana	10	
1304	Einfeldia sp.	10	CG
1466	Elimia sp.	6	SC
1537	Elliptio crassidens	2	
1538	Elliptio dilatata	2	
1536	Elliptio sp.	2	CF
1055	Elmidae	5	CG
1084	Elodes	7	
1431	Empididae	6	PR
551	Enallagma aspersum	6	
552	Enallagma civile	6	
553	Enallagma divagans	6	PR
554	Enallagma exsulans	6	
555	Enallagma geminatum	6	
556	Enallagma hageni	6	
557	Enallagma signatum	6	PR
550	Enallagma sp.	6	PR
558	Enallagma traviatum	6	
559	Enallagma vesperum	6	PR
18	Enchytraeidae	10	CG
1308	Endochironomus nigricans	6	SH
1307	Endochironomus sp.	6	SH
1309	Endochironomus subtendens	6	SH
972	Enochrus cinctus	99.9	
973	Enochrus consortus	99.9	

974	Enochrus hamiltoni	99.9	
975	Enochrus ochraceus	99.9	
976	Enochrus perplexus	99.9	
977	Enochrus pygmaeus	99.9	
978	Enochrus sayi	99.9	
971	Enochrus sp.	99.9	CG
291	Epeorus sp.	1	SC
292	Epeorus vitreus	0	
381	Ephemera simulans	3	CG
380	Ephemera sp.	3	CG
335	Ephemerella aurivillii	2	CG
336	Ephemerella catawba	2	CG
330	Ephemerella cornuta	1	
346	Ephemerella coxalis	4	
337	Ephemerella dorothea	2	CG
338	Ephemerella excrucians	2	CG
352	Ephemerella frisoni	1	
339	Ephemerella invaria	2	CG
332	Ephemerella lata	1	
340	Ephemerella needhami	2	CG
341	Ephemerella rotunda	2	
334	Ephemerella sp.	2	CG
342	Ephemerella subvaria	2	CG
333	Ephemerella walkeri	1	
323	Ephemerellidae	3.5	CG
379	Ephemeridae	5	CG
222	Ephemeroptera	3	CG
392	Ephoron album	2	CG
393	Ephoron leukon	2	CG
391	Ephoron sp.	2	CG
1437	Ephydra sp.	8	CG
1436	Ephydridae	8	CG
448	Epiaeschna heros	1	PR
447	Epiaeschna sp.	1	PR
464	Epicordulia princeps	4.5	PR
463	Epicordulia sp.	4.5	PR
462	Epitheca sp.	4	PR
1258	Epoicocladius sp.	6	CG
1093	Eriocera sp.	7	PR
1094	Erioptera sp.	4	CG
1435	Eristalis sp.	11	CG
404	Erpetogomphus designatus	2	
144	Erpobdella punctata	8	PR
143	Erpobdella sp.	8	
139	Erpobdellidae	8	PR
482	Erythemis simplicicollis	5	PR
481	Erythemis sp.	5	PR
483	Erythrodiplax sp.	5	PR
1259	Eukiefferiella sp.	4	CG
344	Eurylophella aestiva	4	
345	Eurylophella bicolor	4	CG
347	Eurylophella funeralis	4	
348	Eurylophella lutulenta	4	CG

343	Eurylophella sp.	4	SC
349	Eurylophella temporalis	4	CG
873	Fabria inornatus	3.5	
872	Fabria sp.	3.5	SH
200	Fallicambarus fodiens	5	
199	Fallicambarus sp.	5	
1501	Ferrissia rivularis	7	SC
1500	Ferrissia sp.	7	SC
1167	Forcipomyia sp.	5	SC
1486	Fossaria obrussa	7	
1485	Fossaria sp.	7	SC
841	Frenesia missa	3.5	
840	Frenesia sp.	3.5	SH
1540	Fusconaia ebena	1	
1541	Fusconaia flava	1	
1539	Fusconaia sp.	1	
176	Gammaridae	4	CG
189	Gammarus fasciatus	3	CG
187	Gammarus pseudolimnaeus	3	CG
186	Gammarus sp.	3	
188	Gammarus troglophilus	3	
1447	Gastropoda	99.9	SC
644	Gerridae	99.9	PR
645	Gerris sp.	99.9	PR
101	Gloiobdella elongata	8	
102	Glossiphonia	8	PR
103	Glossiphonia complanata	8	PR
92	Glossiphoniidae	8	PR
803	Glossosoma intermedium	3.5	SC
802	Glossosoma sp.	3.5	SC
799	Glossosomatidae	3.5	SC
1311	Glyptotendipes lobiferus	10	SH
1312	Glyptotendipes papipes	10	
1310	Glyptotendipes sp.	10	CF
129	Gnathobdellida	8	PR
842	Goera sp.	3.5	SC
403	Gomphidae	4.5	PR
425	Gomphurus sp.	7	PR
409	Gomphus amnicola	7	
410	Gomphus crassus	7	
411	Gomphus exilis	7	
412	Gomphus externus	7	PR
413	Gomphus graslinellus	7	
414	Gomphus lentulus	7	
415	Gomphus lineatifrons	7	
416	Gomphus lividus	7	PR
417	Gomphus notatus	7	
418	Gomphus plagiatus	7	
419	Gomphus quadricolor	7	
408	Gomphus sp.	7	PR
421	Gomphus spiniceps	7	
420	Gomphus submedianus	7	
422	Gomphus vastus	7	PR

423	Gomphus villosipes	7	
1467	Goniobasis sp.	5	SC
1095	Gonomyia sp.	4	CG
9	Gordius	99.9	
1210	Guttipelopia sp.	6	PR
1262	Gymnometriocnemus sp.	6	
1492	Gyraulus sp.	6	SC
923	Gyrinidae	99.9	PR
928	Gyrinus aeneolus	4	PR
929	Gyrinus analis	4	
927	Gyrinus sp.	4	PR
369	Habrophlebiodes americana	2	
368	Habrophlebiodes sp.	2	SC
132	Haemopis marmorata	7	
131	Haemopis sp.	7	PR
133	Haemopis terrestris	7	
427	Hagenius brevistylus	3	PR
426	Hagenius sp.	3	PR
945	Haliplidae	99.9	SH
947	Haliplus fasciatus	99.9	SH
948	Haliplus immaculicollis	99.9	
949	Haliplus leopardus	99.9	
950	Haliplus pantherinus	99.9	
946	Haliplus sp.	99.9	MH
951	Haliplus triopsis	99.9	
16	Haplotaxida	10	
1313	Harnischia sp.	6	CG
634	Hastaperla brevis	1.5	
633	Hastaperla sp.	1.5	SC
1211	Hayesomyia sp.	5	
638	Hebridae	99.9	PR
639	Hebrus sp.	99.9	PR
1050	Helichus fastigiatus	4	
1051	Helichus lithophilus	4	
1049	Helichus sp.	4	SH
1052	Helichus striatus	4	
880	Helicopsyche borealis	2	SC
879	Helicopsyche sp.	2	SC
878	Helicopsychidae	3.5	SC
1493	Helisoma sp.	7	SC
1096	Helius sp.	5	CG
105	Helobdella elongata	8	PR
106	Helobdella fusca	8	PA
107	Helobdella papillata	8	PR
104	Helobdella sp.	8	PA
108	Helobdella stagnalis	8	PR
109	Helobdella triserialis	8	PA
979	Helocombus sp.	99.9	
465	Helocordulia sp.	2	PR
933	Helodidae	7	SC
1212	Helopelopia sp.	4	PR
980	Helophorus sp.	99.9	SH
1432	Hemerodromia sp.	6	PR

637	Hemiptera	99.9	PR
293	Heptagenia diabasia	4	
297	Heptagenia flavescens	2	
298	Heptagenia hebe	3	
299	Heptagenia lucidipennis	3	
300	Heptagenia maculipennis	3	SC
301	Heptagenia marginalis	1	SC
302	Heptagenia perfida	1	
303	Heptagenia pulla	0	SC
296	Heptagenia sp.	3	SC
286	Heptageniidae	3.5	SC
1097	Hesperoconopa sp.	2	CG
679	Hesperocorixa interrupta	99.9	
680	Hesperocorixa laevigata	99.9	
681	Hesperocorixa lucida	99.9	
682	Hesperocorixa nitida	99.9	
683	Hesperocorixa obliqua	99.9	
678	Hesperocorixa sp.	99.9	PR
684	Hesperocorixa vulgaris	99.9	
844	Hesperophylax designatus	3.5	SH
843	Hesperophylax sp.	3.5	SH
522	Hetaerina americana	3	PR
521	Hetaerina sp.	3	PR
523	Hetaerina titia	3	PR
274	Heterocloeon curiosum	4	SC
273	Heterocloeon sp.	4	SC
1260	Heterotrissocladius sp.	6	CG
383	Hexagenia atrocaudata	6	CG
384	Hexagenia bilineata	6	CG
385	Hexagenia limbata	5	CG
386	Hexagenia munda	5	
387	Hexagenia rigida	6	CG
382	Hexagenia sp.	6	CG
1098	Hexatoma sp.	4	PR
90	Hirudinea	8	PR
130	Hirudinidae	8	PR
1213	Hudsonimyia sp.	6	
175	Hyalella azteca	5	CG
174	Hyalella sp.	4	CG
173	Hyalellidae	4	
1412	Hybomitra sp.	7	PR
1018	Hydaticus modestus	99.9	
1017	Hydaticus sp.	99.9	PR
846	Hydatophylax argus	2	SH
845	Hydatophylax sp.	2	SH
1261	Hydrobaenus sp.	2	SC
1457	Hydrobiidae	6	SC
982	Hydrobius fuscipes	99.9	
981	Hydrobius sp.	99.9	PR
983	Hydrochara sp.	99.9	CG
984	Hydrochus sp.	99.9	SH
618	Hydroperla crosbyi	1	
617	Hydroperla sp.	1	PR

957	Hydrophilidae	99.9	PR
985	Hydrophilus sp.	99.9	PR
1430	Hydrophorus sp.	99.9	PR
1020	Hydroporus clypealis	99.9	
1021	Hydroporus consimilus	99.9	
1022	Hydroporus niger	99.9	
1023	Hydroporus rufilabris	99.9	
1019	Hydroporus sp.	99.9	PR
1024	Hydroporus vittatipennis	99.9	
731	Hydropsyche aerata	5	CF
732	Hydropsyche arinale	5	
733	Hydropsyche betteni	5	CF
734	Hydropsyche bidens	5	
739	Hydropsyche cuanis	5	
740	Hydropsyche dicantha	5	CF
741	Hydropsyche frisoni	5	CF
742	Hydropsyche hageni	5	
743	Hydropsyche incommoda	5	
745	Hydropsyche morosa	4	CF
746	Hydropsyche orris	4	CF
747	Hydropsyche phalerata	2	CF
748	Hydropsyche placoda	4	
750	Hydropsyche scalaris	5	CF
752	Hydropsyche simulans	5	CF
730	Hydropsyche sp.	5	CF
753	Hydropsyche valanis	5	CF
754	Hydropsyche venularis	5	CF
725	Hydropsychidae	5.5	CF
808	Hydroptila sp.	2	SC
809	Hydroptila waubesiana	2	
805	Hydroptilidae	3.5	PH
1026	Hydrovatus pustulatus	99.9	PR
1025	Hydrovatus sp.	99.9	PR
1027	Hygrotus sp.	99.9	PR
1029	Ilybius biguttulus	99.9	
1028	Ilybius sp.	99.9	PR
79	Ilyodrilus sp.	10	
80	Ilyodrilus templetoni	10	CG
221	Insecta	99.9	
847	Ironoquia sp.	3.5	SH
561	Ischnura posita	6	PR
560	Ischnura sp.	6	PR
562	Ischnura verticalis	6	
619	Isogenoides sp.	1.5	PR
234	Isonychia arida	3	
235	Isonychia bicolor	3	CG
236	Isonychia rufa	3	
237	Isonychia sayi	3	
238	Isonychia sicca	3	
233	Isonychia sp.	3	CF
621	Isoperla bilineata	2	
622	Isoperla clio	2	
623	Isoperla confusa	2	

624	Isoperla cotta	2	
625	Isoperla dicala	2	
626	Isoperla lata	2	
627	Isoperla marlynia	2	
628	Isoperla nana	2	
629	Isoperla richardsoni	2	
620	Isoperla sp.	2	PR
152	Isopoda	99.9	CG
810	Ithytrichia sp.	1	SC
1314	Kiefferulus sp.	7	CG
276	Labiobaetis propinquus	4	
275	Labiobaetis sp.	4	
1215	Labrundia neopilosella	4	
1216	Labrundia pilosella	4	
1214	Labrundinia sp.	4	PR
1217	Labrundinia virescens	6	PR
987	Laccobius agilis	99.9	
988	Laccobius minutoides	99.9	
986	Laccobius sp.	99.9	PR
1031	Laccophilus fasciatus	99.9	PR
1032	Laccophilus maculosus	99.9	
1033	Laccophilus proximus	99.9	PR
1030	Laccophilus sp.	99.9	PR
1034	Laccornis sp.	99.9	PR
485	Ladona julia	4.5	
484	Ladona sp.	4.5	PR
1504	Laevapex diaphanus	6	SC
1503	Laevapex fuscus	6	SC
1502	Laevapex sp.	6	SC
1544	Lampsilis fasciola	1	
1548	Lampsilis higginsi	1	
1547	Lampsilis orbiculata	1	
1545	Lampsilis radiata	1	
1542	Lampsilis sp.	1	CF
1543	Lampsilis teres	1	CF
1546	Lampsilis ventricosa	1	
428	Lanthus sp.	6	PR
1218	Larsia sp.	6	PR
1550	Lasmigona complanata	1.5	
1551	Lasmigona compressa	1.5	
1552	Lasmigona costata	1.5	
1549	Lasmigona sp.	1.5	
915	Lepidoptera	99.9	SH
837	Lepidostoma liba	3	
836	Lepidostoma sp.	3	SH
835	Lepidostomatidae	3.5	SH
881	Leptoceridae	3.5	CG
892	Leptocerus americanus	3	
891	Leptocerus sp.	3	SH
1554	Leptodea fragilis	1.5	
1553	Leptodea sp.	1.5	CF
370	Leptophlebia sp.	3	CG
365	Leptophlebiidae	3	CG

848	Leptophylax sp.	3.5	SH
1468	Leptoxis sp.	6	
528	Lestes disjunctus	6	
529	Lestes eurinus	6	
530	Lestes forcipatus	6	
531	Lestes inaequalis	6	
532	Lestes rectangularis	6	
527	Lestes sp.	6	PR
533	Lestes vigilax	6	
524	Lestidae	99.9	PR
674	Lethocerus americans	99.9	
675	Lethocerus griseus	99.9	
673	Lethocerus sp.	99.9	PR
676	Lethocerus uhleri	99.9	
487	Leucorrhinia intacta	4.5	
486	Leucorrhinia sp.	4.5	PR
812	Leucotrichia pictipes	3	
811	Leucotrichia sp.	3	SC
395	Leucrocuta	3	SC
396	Leucrocuta hebe	3	
397	Leucrocuta maculipennis	3	
583	Leuctra sp.	1	SH
582	Leuctridae	1.5	SH
489	Libellula cyanea	8	
490	Libellula incesta	8	PR
491	Libellula luctuosa	8	
492	Libellula pulchella	8	
493	Libellula quadrimaculata	8	
494	Libellula semifasciata	8	PR
488	Libellula sp.	8	PR
495	Libellula vibrans	8	PR
476	Libellulidae	4.5	PR
1556	Ligumia recta	1	
1555	Ligumia sp.	1	CF
1557	Ligumia subrostrata	1	
838	Limnephilidae	3.5	SH
849	Limnephilus sp.	3	SH
82	Limnodrilus cervix	10	CG
83	Limnodrilus claparedianus	10	CG
84	Limnodrilus hoffmeisteri	10	CG
81	Limnodrilus sp.	10	CG
85	Limnodrilus udekemianus	10	CG
647	Limnogonus hesione	99.9	
646	Limnogonus sp.	99.9	PR
1099	Limnophila sp.	4	PR
1442	Limnophora sp.	8	PR
1100	Limonia sp.	3	SH
1035	Liodessus sp.	99.9	PR
1451	Lioplax sp.	7	SC
1315	Lipiniella sp.	6	
168	Lirceus fontinalis	4	CG
169	Lirceus garmani	4	CG
170	Lirceus lineatus	4	CG

171	Lirceus louisianae	4	
167	Lirceus sp.	4	CG
1083	Listronotus sp.	99.9	CF
1469	Lithasia sp.	6	
19	Lumbricidae	10	CG
14	Lumbriculida	10	
15	Lumbriculidae	10	CG
1484	Lymnaea sp.	7	SC
1482	Lymnaeidae	7	SC
796	Lype diversa	3.5	SC
795	Lype sp.	3.5	SC
135	Macrobdella decora	7	
134	Macrobdella sp.	7	
455	Macromia georgina	3	PR
456	Macromia illinoiensis	3	PR
457	Macromia pacifica	3	
454	Macromia sp.	3	PR
458	Macromia taeniolata	3	PR
451	Macromiidae	4.5	PR
755	Macronema sp.	2	CF
757	Macronema zebratum	2	CF
1064	Macronychus glabratus	2	
1063	Macronychus sp.	2	
1219	Macropelopia sp.	7	PR
756	Macrostemum sp.	2	CF
1142	Mansonia perturbans	8	
1141	Mansonia sp.	8	CG
1461	Marstonia sp.	6	
1037	Matus bicarinatus	99.9	
1036	Matus sp.	99.9	PR
814	Mayatrichia ayama	1	SC
813	Mayatrichia sp.	1	SC
1559	Megalonaias nervosa	1.5	
1558	Megalonaias sp.	1.5	
701	Megaloptera	3.5	
1494	Menetus sp.	6.5	SC
1220	Meropelopia sp.	3	
640	Merragata sp.	99.9	PR
1448	Mesogastropoda	6	SC
643	Mesovelia mulsanti	99.9	PR
642	Mesovelia sp.	99.9	PR
641	Mesoveliidae	99.9	PR
239	Metretopodidae	3	
1263	Metriocnemus sp.	6	CG
648	Metrobates sp.	99.9	PR
834	Micrasema rusticum	3.5	
833	Micrasema sp.	3.5	MH
1316	Microchironomus sp.	6	CG
1066	Microcylloepus pusillus	2	CG
1065	Microcylloepus sp.	2	CG
1374	Micropsectra sp.	4	CG
1318	Microtendipes caducus	6	
1319	Microtendipes pedellus	6	CF

1317	Microtendipes sp.	6	CF
652	Microvelia sp.	99.9	PR
864	Molanna blenda	3.5	
863	Molanna sp.	3.5	SC
865	Molanna tryphena	3.5	
866	Molanna uniophila	3.5	
862	Molannidae	3.5	CG
1446	Mollusca	99.9	
1168	Monohelea sp.	5	PR
146	Mooreobdella fervida	8	
147	Mooreobdella microstoma	8	PR
145	Mooreobdella sp.	8	PR
917	Munroessa sp.	99.9	SH
1441	Muscidae	8	PR
1597	Musculium sp.	5	CF
1598	Musculium transversum	5	CF
894	Mystacides sepulchralis	2	
893	Mystacides sp.	2	CG
123	Myzobdella lugubris	7	PR
122	Myzobdella sp.	7	
21	Naididae	10	CG
41	Nais barbata	10	CG
42	Nais behningi	10	CG
43	Nais bretscheri	10	CG
44	Nais communis	10	CG
45	Nais elinguis	10	CG
46	Nais pardalis	10	CG
47	Nais simplex	10	CG
40	Nais sp.	10	CG
48	Nais variabilis	10	CG
1265	Nanocladius distinctus	3	CG
1264	Nanocladius sp.	3	CG
450	Nasiaeschna pentacantha	2	PR
449	Nasiaeschna sp.	2	PR
1221	Natarsia sp.	6	PR
660	Naucoridae	99.9	PR
896	Nectopsyche albida	3	
897	Nectopsyche candida	3	
898	Nectopsyche diarina	3	
899	Nectopsyche exquisita	3	
900	Nectopsyche pavida	3	
895	Nectopsyche sp.	3	SH
564	Nehalennia gracilis	7	
565	Nehalennia irene	7	
563	Nehalennia sp.	7	PR
8	Nematomorpha	99.9	PA
578	Nemoura sp.	1	SH
579	Nemoura venosa	1	
576	Nemouridae	1.5	SH
605	Neoperla clymene	1	PR
604	Neoperla sp.	1	PR
851	Neophylax concinnus	3	
850	Neophylax sp.	3	SC

658	Neoplea sp.	99.9	PR
659	Neoplea striola	99.9	
815	Neotrichia sp.	4	SC
665	Nepa apiculata	99.9	
664	Nepa sp.	99.9	PR
149	Nephelopsis obscura	8	PR
148	Nephelopsis sp.	8	
663	Nepidae	99.9	PR
783	Neureclipsis bimaculata	3	CF
782	Neureclipsis crepuscularis	3	CF
781	Neureclipsis sp.	3	CF
467	Neurocordulia molesta	3	PR
468	Neurocordulia obsoleta	3	PR
466	Neurocordulia sp.	3	PR
469	Neurocordulia yamaskanensis	3	
718	Neuroptera	99.9	PR
716	Nigronia fasciatus	2	PR
717	Nigronia serricornis	2	PR
715	Nigronia sp.	2	PR
1169	Nilobezzia sp.	5	PR
1223	Nilotanypus fimbriatus	6	PR
1222	Nilotanypus sp.	6	PR
1320	Nilothauma sp.	3	
295	Nixe perfida	4	
294	Nixe sp.	4	SC
656	Notonecta sp.	99.9	PR
654	Notonectidae	99.9	PR
784	Nyctiophylax sp.	1	CF
918	Nymphula sp.	99.9	SH
1561	Obliquaria reflexa	1	
1560	Obliquaria sp.	1	
1563	Obovaria olivaria	1.5	
1562	Obovaria sp.	1.5	
1564	Obovaria subrotunda	1.5	
816	Ochrotrichia sp.	4	CG
398	Odonata	99.9	PR
1240	Odontomesa sp.	6	CG
1388	Odostomia cincta	10	
1387	Odostomia sp.	10	CG
902	Oecetis avara	5	PR
903	Oecetis cinerascens	5	PR
904	Oecetis eddlestoni	5	PR
905	Oecetis inconspicua	5	PR
906	Oecetis nocturna	5	
907	Oecetis ochracea	5	
901	Oecetis sp.	5	PR
570	Oemopteryx glacialis	1.5	
569	Oemopteryx sp.	1.5	SH
11	Oligochaeta	10	CG
232	Oligoneuriidae	3	CF
875	Oligostomis ocelligera	3.5	PR
874	Oligostomis sp.	3.5	PR
52	Ophidonais serpentina	10	CG

51	Ophidonais sp.	10	
430	Ophiogomphus rupinsulensis	2	
429	Ophiogomphus sp.	2	PR
1068	Optioservus fastiditus	4	SC
1069	Optioservus ovalis	4	SC
1067	Optioservus sp.	4	SC
1070	Optioservus trivittatus	4	SC
212	Orconectes bisectus	5	
202	Orconectes illinoiensis	5	
203	Orconectes immunis	5	
204	Orconectes indianensis	5	
205	Orconectes kentuckiensis	5	
206	Orconectes lancifer	5	
207	Orconectes placidus	5	
208	Orconectes propinquus	5	
209	Orconectes rusticus	5	
201	Orconectes sp.	5	
210	Orconectes stannardi	5	
211	Orconectes virilis	5	
1101	Ormosia sp.	4	CG
1246	Orthocladiinae sp.	6	CG
1266	Orthocladius sp.	4	CG
1247	Orthocladius/cricotopus sp.	6	
817	Orthotrichia sp.	1	SC
1389	Oxycera sp.	10	SC
818	Oxyethira sp.	2	MH
497	Pachydiplax longipennis	8	PR
496	Pachydiplax sp.	8	PR
1332	Pagastiella sp.	6	
220	Palaemonetes kadiakensis	4	
219	Palaemonetes sp.	4	
218	Palaemonidae	99.9	
686	Palmacorixa buenoi	99.9	
687	Palmacorixa gilletteii	99.9	
688	Palmacorixa nana	99.9	
685	Palmacorixa sp.	99.9	PR
1170	Palpomyia sp.	6	PR
499	Pantala flavescens	7	
500	Pantala hymenaea	7	
498	Pantala sp.	7	PR
592	Paracapnia angulata	1.5	
593	Paracapnia opis	1.5	
591	Paracapnia sp.	1.5	SH
1322	Parachironomus carinatus	8	PR
1323	Parachironomus directus	8	
1324	Parachironomus frequens	8	
1325	Parachironomus monochromus	8	
1326	Parachironomus pectinatella	4	
1321	Parachironomus sp.	8	PR
1327	Parachironomus tenuicaudatus	8	
1328	Paracladopelma sp.	4	CG
285	Paracloeodes minutus	5	
284	Paracloeodes sp.	4	SC

989	Paracymus sp.	99.9	PR
990	Paracymus subcupreus	99.9	
607	Paragnetina media	1.5	PR
606	Paragnetina sp.	1.5	PR
1267	Parakiefferiella sp.	5	
1330	Paralauterborniella nigrohalteralis	6	
1329	Paralauterborniella sp.	6	CG
372	Paraleptophlebia moerens	2	
373	Paraleptophlebia ontario	2	
374	Paraleptophlebia praepedita	2	
371	Paraleptophlebia sp.	2	CG
375	Paraleptophlebia sticta	2	
1224	Paramerina sp.	6	PR
1268	Parametriocnemus sp.	4	CG
50	Paranais frici	10	
49	Paranais sp.	10	
1269	Paraphaenocladius sp.	6	CG
919	Paraponyx sp.	99.9	SH
759	Parapsyche apicalis	5.5	
758	Parapsyche sp.	5.5	PR
1375	Paratanytarsus sp.	6	CG
1333	Paratendipes albimanus	3	
1331	Paratendipes sp.	3	CG
1102	Pedicia sp.	4	PR
1505	Pelecypoda	99.9	CF
662	Pelocoris femoratus	99.9	PR
661	Pelocoris sp.	99.9	PR
1054	Pelonomus obscurus	4	
1053	Pelonomus sp.	4	CG
954	Peltodytes dunavani	99.9	
953	Peltodytes duodecimpuntatus	99.9	
955	Peltodytes lengi	99.9	
956	Peltodytes sexmaculatus	99.9	
952	Peltodytes sp.	99.9	SH
388	Pentagenia	4	CF
389	Pentagenia vittigera	4	CG
1225	Pentaneura sp.	3	PR
1159	Pericoma sp.	11	CG
501	Perithemis sp.	4	PR
502	Perithemis tenera	4	PR
610	Perlesta placida	4	
608	Perlesta sp.	4	PR
594	Perlidae	1.5	PR
612	Perlinella drymo	2	PR
613	Perlinella ephyre	2	PR
611	Perlinella sp.	2	PR
616	Perlodidae	1.5	PR
920	Petrophila sp.	5	SC
1335	Phaenopsectra flavipes	4	SC
1336	Phaenopsectra obediens gr	4	
1337	Phaenopsectra punctipes gr	4	
1334	Phaenopsectra sp.	4	SC
138	Pharyngobdellidae	8	PR

615	Phasganophora capitata	1.5	
614	Phasganophora sp.	1.5	PR
137	Philobdella gracilis	7	PR
136	Philobdella sp.	7	
768	Philopotamidae	3.5	CF
876	Phryganea sp.	3	
867	Phryganeidae	3.5	SH
786	Phylocentropus placidus	3.5	
785	Phylocentropus sp.	3.5	CF
1478	Physa acuta	9	
1479	Physa integra	9	CG
1477	Physa sp.	9	SC
1481	Physella sayi	9	
1480	Physella sp.	9	SC
1475	Physidae	9	SC
1103	Pilaria sp.	4	PR
125	Piscicola milneri	7	PR
126	Piscicola punctata	7	PR
124	Piscicola sp.	7	PR
128	Piscicolaria reducta	7	
127	Piscicolaria sp.	7	
119	Piscicolidae	7	
1595	Pisidiidae	5	
1599	Pisidium sp.	5	CF
110	Placobdella montifera	8	PR
112	Placobdella multilineata	8	PR
113	Placobdella ornata	8	PR
114	Placobdella papillifera	8	PA
115	Placobdella parasitica	8	PA
116	Placobdella pediculata	8	
111	Placobdella sp.	8	PR
1565	Plagiola lineolata	1.5	
7	Planaria sp.	6	
4	Planariidae	6	
1495	Planorbella sp.	6.5	SC
1496	Planorbella truncata	6.5	
1491	Planorbidae	6.5	SC
1497	Planorbula sp.	7	SC
504	Plathemis lydia	3	PR
503	Plathemis sp.	3	PR
853	Platycentropus radiatus	3	
852	Platycentropus sp.	3	SH
1	Platyhelminthes	99.9	
277	Plauditus sp.	3	
566	Plecoptera	1.5	PR
657	Pleidae	99.9	PR
1567	Plethobasus cyphyus	1.5	
1566	Plethobasus sp.	1.5	
1569	Pleurobema cordatum	1.5	
1568	Pleurobema sp.	1.5	
1471	Pleurocera acuta	7	SC
1470	Pleurocera sp.	7	SC
1465	Pleuroceridae	6	

778	Polycentropodidae	3.5	CF
788	Polycentropus centralis	3	PR
789	Polycentropus cinereus	3	PR
790	Polycentropus flavus	3	PR
791	Polycentropus glacialis	3	PR
792	Polycentropus interuptus	3	PR
793	Polycentropus remotus	3	PR
787	Polycentropus sp.	3	PR
390	Polymitarcyidae	3	CG
1339	Polypedilum convictum	6	SH
1346	Polypedilum digitifer	6	SH
1341	Polypedilum fallax	6	SH
1342	Polypedilum halterale	4	SH
1343	Polypedilum illinoense	5	SH
1340	Polypedilum obtusum	6	SH
1344	Polypedilum scalaenum	6	SH
1345	Polypedilum simulans	6	SH
1338	Polypedilum sp.	6	SH
1472	Pomatiopsidae	6	
1473	Pomatiopsis sp.	6	
376	Potamanthidae	5	CF
378	Potamanthus myops	4	
88	Potamothrix vejdovskyi	10	
761	Potamyia flava	4	CF
760	Potamyia sp.	4	CF
1241	Potthastia sp.	6	
1104	Prionocera sp.	4	SH
1085	Prionocyphon sp.	7	SC
54	Pristina aequiseta	10	CG
56	Pristina breviseta	10	CG
55	Pristina leidyi	10	CG
57	Pristina longiseta	10	
58	Pristina osborni	10	CG
53	Pristina sp.	10	CG
59	Pristina synclites	10	CG
1171	Probezzia sp.	5	PR
1462	Probythinella sp.	6	
214	Procambarus acutus	5	SH
215	Procambarus clarki	5	
216	Procambarus gracilis	5	
213	Procambarus sp.	5	SH
217	Procambarus viaeviridis	5	
1226	Procladius sp.	8	PR
269	Procloeon sp.	4	
1242	Prodiamesa sp.	3	CG
432	Progomphus obscurus	5	PR
431	Progomphus sp.	5	PR
1498	Promenetus sp.	6.5	CG
1071	Promoresia sp.	5	SC
1571	Proptera alata	1	
1572	Proptera capax	1	
1573	Proptera laevissimus	1	
1570	Proptera sp.	1	

1178	Prosimulium magnum	2	
1179	Prosimulium mixtum	2	
1177	Prosimulium sp.	2	CF
580	Prostoia sp.	1.5	SH
804	Protoptila sp.	1	SC
1270	Psectrocladius sp.	5	CG
1227	Psectrotanypus sp.	8	PR
930	Psephenidae	4	SC
932	Psephenus herricki	4	SC
931	Psephenus sp.	4	SC
1348	Pseudochironomus fulviventris	5	
1349	Pseudochironomus prasinatus	5	
1347	Pseudochironomus sp.	5	CG
279	Pseudocloeon carolina	4	
280	Pseudocloeon dubium	4	SC
281	Pseudocloeon myrsum	4	
282	Pseudocloeon parvulum	4	
283	Pseudocloeon punctiventris	4	
278	Pseudocloeon sp.	4	SC
1243	Pseudodiamesa sp.	1	CG
1105	Pseudolimnophila sp.	2	PR
1271	Pseudorthocladius sp.	6	CG
854	Pseudostenophylax sp.	3.5	SH
855	Pseudostenophylax uniformis	3.5	
1488	Pseudosuccinea columella	7	SC
1487	Pseudosuccinea sp.	7	SC
1144	Psorophora ciliata	8	
1145	Psorophora confinnis	8	PR
1146	Psorophora cyanescens	8	
1147	Psorophora discolor	8	
1148	Psorophora ferox	8	
1149	Psorophora horrida	8	
1150	Psorophora howardi	8	
1143	Psorophora sp.	8	PR
1151	Psorophora varipes	8	
1160	Psychoda sp.	11	CG
1157	Psychodidae	11	CG
798	Psychomyia flavida	2	CG
797	Psychomyia sp.	2	SC
794	Psychomyiidae	3.5	CG
567	Pteronarcys	2	SH
877	Ptilostomis sp.	3	SH
1575	Ptychobranchus fasciolaris	1.5	
1574	Ptychobranchus sp.	1.5	
1385	Ptychoptera sp.	8	CG
1383	Ptychopteridae	8	CG
857	Pycnopsyche guttifer	3	SH
858	Pycnopsyche lepida	3	
859	Pycnopsyche luculenta	3	
860	Pycnopsyche scabripennis	3	SH
856	Pycnopsyche sp.	3	SH
861	Pycnopsyche subfasciata	3	SH
916	Pyralidae	99.9	SH

1463	Pyrgulopsis sp.	6	SC
1577	Quadrula cyclindrica	1.5	
1578	Quadrula metanerva	1.5	
1579	Quadrula nodulata	1.5	
1580	Quadrula pustulosa	1.5	
1581	Quadrula quadrula	1.5	
1576	Quadrula sp.	1.5	
89	Quistradrilus multisetosus	10	CG
690	Ramphocorixa acuminata	99.9	
689	Ramphocorixa sp.	99.9	PR
666	Ranatra fusca	99.9	PR
668	Ranatra kirkaldyi	99.9	PR
669	Ranatra nigra	99.9	PR
667	Ranatra sp.	99.9	PR
635	Rasvena sp.	1.5	
636	Rasvena terna	1.5	CG
653	Rhagovelia sp.	99.9	PR
1039	Rhantus binotatus	99.9	
1038	Rhantus sp.	99.9	PR
1273	Rheocricotopus fuscipes	6	
1274	Rheocricotopus robacki	6	
1272	Rheocricotopus sp.	6	CG
1228	Rheopelopia sp.	3	PR
1376	Rheotanytarsus sp.	6	CF
649	Rheumatobates sp.	99.9	PR
305	Rhithrogena pellucida	0	SC
304	Rhithrogena sp.	0	SC
823	Rhyacophila fenestra	1	
824	Rhyacophila fuscula	1	PR
825	Rhyacophila lobifera	1	
822	Rhyacophila sp.	1	PR
826	Rhyacophila vibox	1	
821	Rhyacophilidae	3.5	PR
91	Rhynchobdellida	8	
1350	Robackia sp.	3	CG
1351	Saetheria sp.	6	CG
1438	Sciomyzidae	10	PR
943	Scirtes orbiculatus	7	
942	Scirtes sp.	7	SH
944	Scirtes tibialis	7	
1352	Seatheria tylus	4	
913	Sericostomatidae	3.5	SH
351	Serratella deficiens	1	CG
353	Serratella sordida	1	CG
350	Serratella sp.	1	CG
908	Setodes sp.	3.5	
702	Sialidae	3.5	PR
704	Sialis infumata	4	
705	Sialis itasca	4	
706	Sialis mohri	4	PR
703	Sialis sp.	4	PR
707	Sialis vagans	4	
708	Sialis velata	4	

692	Sigara alternata	99.9	
693	Sigara compressoidea	99.9	
694	Sigara hubbelli	99.9	
695	Sigara modesta	99.9	
696	Sigara signata	99.9	
691	Sigara sp.	99.9	PR
1174	Simuliidae	6	CF
1181	Simulium clarkei	4	
1182	Simulium corbis	0	
1183	Simulium decorum	4	CF
1184	Simulium jenningsi	4	CF
1185	Simulium luggeri	2	
1186	Simulium meridionale	1	CF
1180	Simulium sp.	6	CF
1187	Simulium tuberosum	4	CF
1188	Simulium venustum	6	CF
1189	Simulium verecundum	6	
1190	Simulium vittatum	8	CF
223	Siphlonuridae	3	CG
229	Siphlonurus alternatus	2	
230	Siphlonurus quebecensis	2	
231	Siphlonurus rapidus	2	
228	Siphlonurus sp.	2	CG
241	Siphloplecton basale	2	
242	Siphloplecton interlineatum	2	
240	Siphloplecton sp.	2	CG
722	Sisyra sp.	1	PR
723	Sisyra vicaria	1	
719	Sisyridae	1	PR
61	Slavina appendiculata	10	CG
60	Slavina sp.	10	CG
1275	Smittia sp.	6	CG
471	Somatochlora filosa	1	
472	Somatochlora linearis	1	PR
470	Somatochlora sp.	1	PR
473	Somatochlora tenebrosa	1	
1464	Somatogyrus sp.	6	
581	Soyedina sp.	1.5	SH
63	Specaria josinae	10	CG
62	Specaria sp.	10	CG
1596	Sphaeriidae	5	
1600	Sphaerium sp.	5	CG
1172	Sphaeromias sp.	5	
820	Stactobiella palmata	3.5	
819	Stactobiella sp.	3.5	SH
1490	Stagnicola emarginatus	7	
1489	Stagnicola sp.	7	SC
1355	Stelechomyia	6	CG
1356	Stelechomyia pulpulchra	6	CG
1377	Stempellina sp.	2	CG
1378	Stempellinella sp.	2	CG
307	Stenacron interpunctatum	4	
306	Stenacron sp.	4	SC

1073	Stenelmis bicarinata	7	SC
1074	Stenelmis crenata	7	
1075	Stenelmis decorata	7	SC
1076	Stenelmis lateralis	7	SC
1077	Stenelmis markeli	7	SC
1078	Stenelmis mera	7	SC
1079	Stenelmis musgravei	7	SC
1080	Stenelmis sexlineata	7	SC
1072	Stenelmis sp.	7	SC
1081	Stenelmis vittipennis	6	
1354	Stenochironomus hilaris	3	CG
1353	Stenochironomus sp.	3	SH
318	Stenonema annexum	4	
309	Stenonema ares	3	
310	Stenonema exiguum	5	
312	Stenonema femoratum	7	SC
313	Stenonema integrum	4	
314	Stenonema luteum	1	SC
315	Stenonema mediopunctatum	2	SC
317	Stenonema modestum	3	SC
316	Stenonema nepotellum	5	
319	Stenonema pulchellum	3	SC
311	Stenonema quinquespinum	5	
320	Stenonema rubromaculatum	2	
308	Stenonema sp.	4	SC
321	Stenonema terminatum	4	SC
322	Stenonema vicarium	3	SC
64	Stephensoniana sp.	10	
65	Stephensoniana trivandrana	10	CG
1358	Stictochironomus caffrarius	5	
1359	Stictochironomus devinctus	5	
1357	Stictochironomus sp.	5	
1173	Stilbezzia sp.	5	
1276	Stilocladius sp.	6	
1386	Stratiomyidae	10	CG
1391	Stratiomys discalis	10	
1392	Stratiomys meigeni	10	
1390	Stratiomys sp.	10	CF
1582	Strophitus sp.	4	
1583	Strophitus undulatus	4	
572	Strophopteryx fasciata	1.5	SH
571	Strophopteryx sp.	1.5	
177	Stygobromus sp.	4	PR
178	Stygobromus subtilis	4	
67	Stylaria fossularis	10	CG
68	Stylaria lacustris	10	CG
66	Stylaria sp.	10	
434	Stylogomphus albistylus	4.5	PR
433	Stylogomphus sp.	4.5	PR
424	Stylurus sp.	7	PR
1379	Sublettea sp.	6	CF
506	Sympetrum ambiguum	4	PR
507	Sympetrum corruptum	4	

508	Sympetrum obstrusum	4	
509	Sympetrum rubicundulum	4	
510	Sympetrum semicinctum	4	
505	Sympetrum sp.	4	PR
511	Sympetrum vicinum	4	
1244	Sympotthastia sp.	6	CG
921	Synclita sp.	99.9	SH
1245	Syndiamesa sp.	6	CG
1433	Syrphidae	11	CG
1393	Tabanidae	7	PR
1414	Tabanus atratus	7	
1415	Tabanus cymatophorus	7	
1416	Tabanus fairchildi	7	
1417	Tabanus lineola	7	
1418	Tabanus marginalis	7	
1419	Tabanus nigrescens	7	
1420	Tabanus pumilus	7	
1421	Tabanus quinquevittatus	7	
1422	Tabanus reinwardtii	7	
1413	Tabanus sp.	7	PR
1423	Tabanus sparus	7	
1424	Tabanus stygius	7	
1425	Tabanus subsimilis	7	
1426	Tabanus sulcifrons	7	
1427	Tabanus superjumentarius	7	
1428	Tabanus trimaculatus	7	
568	Taeniopterygidae	1.5	SH
574	Taeniopteryx nivalis	2	SH
575	Taeniopteryx parvula	2	SH
573	Taeniopteryx sp.	2	SH
1192	Tanypodinae sp.	6	PR
1230	Tanypus carinatus	8	
1231	Tanypus neopunctipennis	8	
1232	Tanypus punctipennis	8	
1229	Tanypus sp.	8	PR
1233	Tanypus stellatus	8	
1366	Tanytarsini sp.	6	CF
1382	Tanytarsus glabrescan	7	
1381	Tanytarsus guerlus	7	
1380	Tanytarsus sp.	7	CF
1158	Telmatoscopus sp.	11	CG
475	Tetragoneuria cynosura	4.5	PR
474	Tetragoneuria sp.	4.5	PR
1041	Thermonectus basillaris	99.9	PR
1042	Thermonectus ornaticollis	99.9	
1040	Thermonectus sp.	99.9	PR
118	Theromyzon biannulatum	8	
117	Theromyzon sp.	8	PR
1278	Thienemanniella sp.	2	CG
1279	Thienemanniella xena	2	CG
1235	Thienemannimyia senata	6	
1234	Thienemannimyia sp.	6	PR
1090	Tipula sp.	4	SH

1089	Tipulidae	4	SH
394	Tortopus sp.	4	CG
1527	Toxolasma paruvus	7	
1529	Toxolasma texasensis	7	
513	Tramea carolina	4	PR
514	Tramea lacerata	4	
515	Tramea onusta	4	
512	Tramea sp.	4	PR
650	Trepobates sp.	99.9	PR
910	Triaenodes injustus	3	
911	Triaenodes marginatus	3	sh
909	Triaenodes sp.	3	MH
912	Triaenodes tardus	3	SH
1361	Tribelos fuscicorne	4	CG
1362	Tribelos jucundus	5	
1360	Tribelos sp.	5	CG
698	Trichocorixa calva	99.9	
699	Trichocorixa kanza	99.9	
700	Trichocorixa macroceps	99.9	
697	Trichocorixa sp.	99.9	PR
724	Trichoptera	3.5	
3	Tricladida	6	CG
354	Tricorythidae	5.5	CG
355	Tricorythodes sp.	5	CG
1584	Tritogonia sp.	1	
1585	Tritogonia verrucosa	1	
992	Tropisternus blatchleyi	99.9	
993	Tropisternus lateralis	99.9	CG
994	Tropisternus mixtus	99.9	
995	Tropisternus natator	99.9	
991	Tropisternus sp.	99.9	PR
1587	Truncilla donaciformis	1	
1586	Truncilla sp.	1	
1588	Truncilla truncata	1	
86	Tubifex sp.	10	CG
87	Tubifex tubifex	10	CG
20	Tubificida	10	CG
75	Tubificidae	10	CG
2	Turbellaria	6	PR
1277	Tvetenia sp.	5	
69	Uncinais sp.	10	
70	Uncinais uncinata	10	
1589	Uniomerus sp.	1.5	
1590	Uniomerus tetralasmus	1.5	
1507	Unionidae	1.5	CF
1506	Unionoida	1.5	
1153	Uranotaenia sapphirina	8	
1152	Uranotaenia sp.	8	CF
1043	Uvarus sp.	99.9	PR
1454	Valvata sp.	2	SC
1453	Valvatidae sp.	6	SC
72	Vejdovskyella intermedia	10	CG
71	Vejdovskyella sp.	10	CG

651	Veliidae	99.9	PR
1594	Venerioda	5	
1592	Villosa iris	1	
1593	Villosa lienosa	1	
1591	Villosa sp.	1	
1449	Viviparidae	6	SC
1452	Viviparus sp.	1	SC
74	Wapsa mobilis	10	
73	Wapsa sp.	10	
777	Wormaldia shawnee	3.5	
776	Wormaldia sp.	3.5	CF
1363	Xenochironomus sp.	4	PR
1364	Xenochironomus xenolabis	6	
1365	Xestochironomus sp.	6	
1280	Zalutschia sp.	6	SH
1237	Zavrelimyia sinuosa com	8	
1236	Zavrelimyia sp.	8	PR
516	Zygoptera sp.	99.9	PR
1285	Zylotopus par	6	

Calculation of Fish Index of Biotic Integrity (fIBI)for Stream sites in the North Mill Creek watershed in Lake County, Illinois.

This appendix to the Quality Assurance Project Plan (QAPP) for the North Mill Creek Watershed Biological Monitoring Project explains the methodology for calculating the fish index of biotic integrity (fIBI) for all three proposed biological monitoring sites (North Mill Creek at IL Route 173, Hastings Creek at Miller Road, and North Mill Creek at Old Kelly Road). The fIBI is a dimensionless index or "score" that represents how much the biotic integrity (as represented by the fish community, in this case) deviates from a benchmark or reference condition. In Illinois, the reference condition is usually considered to be one in which waters have been undisturbed or slightly disturbed by human activity (IL EPA, 2005).

The Illinois Environmental Protection Agency (IL EPA) uses fIBI scores, in part, to assess human impacts to water resources and attainment of designated uses of those resources. To do so, IL EPA has developed a classification scale for fIBI scores that divide streams into five "integrity classes" ranging from the least impacted to most impacted (IL EPA, 2005). One goal of this monitoring project is to collect data that will allow for calculation of an fIBI score for each sampling station that can be considered by IL EPA along with other environmental data to determine the use attainment of the streams in the North Mill Creek Watershed.

The Illinois fIBI score is comprised of ten individual metric scores reflecting the composition of the fish community. The possible score for each metric ranges from 0-6, so the maximum possible fIBI score for a site is 60. The ten metrics used by IL EPA are included in Table 1. Generally, the metrics measure species richness, trophic and reproductive structure (ecological "niches"), and tolerance of disturbance.

Table 1. IL EPA Fish IBI Metrics (IL EPA, 2005)

fIBI Metric	**Description**
Native Fish Species	Native fish species present
Native Minnow Species	Native species of Family Cyprinidae
Native Sucker Species	Native species of Family Catostomidae
Native Sunfish Species	Native species of Family Centrarchidae
Native Benthic Invertivore Species	Native species of benthic invertebrate specialist feeders
Intolerant Species	Native species intolerant of disturbed conditions
Proportion Specialist Benthic Invertivores	Proportion of individuals as benthic invertebrate specialist feeders
Proportion Generalist Feeders	Proportion of individuals as generalist feeders
Proportion Mineral-Substrate Spawners	Proportion of individuals as coarse-mineral substrate spawners and not "tolerant"
Proportion Tolerant Species	Proportion of individuals as species tolerant of disturbed conditions

In developing the methodology for calculating fIBI scores for Illinois streams, IL EPA recognized that underlying environmental conditions, independent of human influences, vary considerably across the State. Even under "undisturbed" conditions, fish communities and species diversity would be expected to vary according to local environmental conditions. Therefore, IL EPA demarcated 13 "IBI regions" to reflect the natural variability that would be expected even under reference conditions in Illinois (see

Figure 1). All three biological monitoring sites in the North Mill Creek watershed fall into IBI Region 3 (which includes all of the Des Plaines River basin in Illinois).

In addition to expected geographic differences in species richness across Illinois, calculation of fIBI according to IL EPA methods also accounts for differences in stream size (wetted channel width) and slope. For any given level of environmental disturbance, fish community composition would be expected to change as streams increase in width or slope. In IBI Region 3, stream slope is not a significant determinant of species richness, so all ten fIBI metrics are assumed to vary dependent upon stream width. The scoring curves for each of the ten metrics for IBI Region 3 are included at the end of this Appendix. Note, for instance, that the number of native fish species that would result in a metric score of "4" increases with wetted stream width. This is due to the assumption that in IBI Region 3, there is a positive relationship between stream size and number of species present.

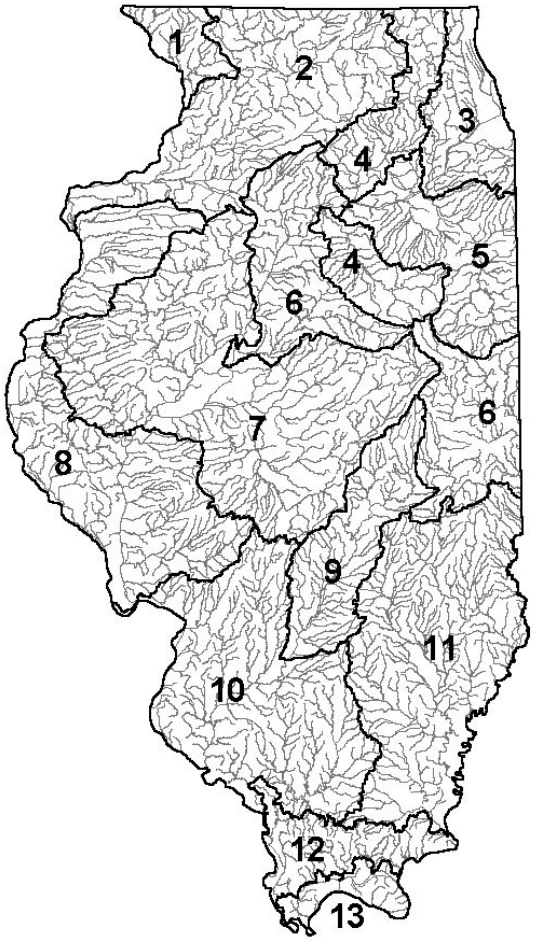


Figure 1. IBI Regions in Illinois. Region 4 comprises two noncontiguous areas.

METRIC AND IBI SCORING

Scoring for each metric is relatively simple. After processing the field sample for a site, the number of individuals of each species and wetted width of the sample reach should be entered into a fish information spreadsheet. The spreadsheet automatically calculates the values for each metric. The relationships used to calculate each metric are described below:

Native Fish Species = ΣX

Where *X* is the number of native fish species present in the sample.

Native Minnow Species = ΣX

Where *X* is the number of native minnow species (Family Cyprinidae) present in the sample.

Native Sucker Species = ΣX

Where *X* is the number of native sucker species (Family Catostomidae) present in the sample.

Native Sunfish Species = ΣX

Where *X* is the number of native sunfish species (Family Centrarchidae) present in the sample.

Native Benthic Invertivore Species = ΣX

Where *X* is the number of native benthic invertivore species, as noted on the species list included below. This includes both specialist and generalist feeders that primarily feed on benthic (stream-bottom) invertebrates. For an explanation of the terminology, see the explanatory notes on the species list.

Intolerant Species = ΣX

Where *X* is the number of native species intolerant of disturbed conditions, as noted on the species list included below.

Proportion Specialist Benthic Invertivores = n_i/N

Where n_i is the number of individuals belonging to species categorized as Specialist Benthic Invertivores, as noted on the species list included below, and N is the total number of individuals in the sample. Specialist Benthic Invertivores are differentiated from Native Benthic Invertivores (above), in that this metric includes only specialist feeders. For an explanation of terminology, see the explanatory notes on the species list.

Proportion Generalist Feeders = n_i/N

Where n_i is the number of individuals belonging to species categorized as generalist feeders, as noted on the species list included below, and N is the total number of individuals in the sample. Generalist feeders typically feed on three or more food types.

Proportion Mineral-Substrate Spawners = n_i/N

Where n_i is the number of individuals belonging to species categorized as mineral-substrate spawners (lithophils), excluding species categorized as tolerant, and N is the total number of individuals in the sample. For an explanation of terminology, see the explanatory notes on the species list.

Proportion Tolerant Species = n_i/N

Where n_i is the number of individuals belonging to species categorized as tolerant of disturbed conditions, and N is the total number of individuals in the sample.

A list showing those species that satisfy each metric is included in this appendix. Based on the metric value, a metric score from 0 to 6 should be applied using the IBI

Region 3 metric scoring charts included in this Appendix. Wetted stream width (in feet) of the sample reach is required to score each metric. Using the chart, for a given wetted stream width, *x*, a number of species or proportion of individuals, *y*, will fall into one of the six scores. Metrics for which the number of representative species or proportion of individuals is zero (or the proportion is 1.0 for generalist feeders and tolerant species), the metric score is zero. For a rationale of the score assignments for the metrics, see Smogor, et al (2000).

After assigning a score to each of the ten metrics, the metric scores are summed to yield the fIBI score. This score will fall between 0 and 60. For a description of the integrity classes developed by IL EPA for fIBI score ranges, please see IL EPA 2005.

Literature Cited

IL EPA (Illinois Environmental Protection Agency). 2005. Interpreting Illinois Fish-IBI Scores: Draft: January 2005. Springfield: Illinois Environmental Protection Agency, Bureau of Water.

Smogor, R. and others, 2000, rev. 2006. Draft Manual for Calculating Index of Biotic Integrity Scores for Streams in Illinois. Springfield: Illinois Environmental Protection Agency, Bureau of Water.

APPENDIX H: Calculation of Fish IBI

Revised as of 01/11/2002
Mineral-substrate Spawner column changed to Mineral-substrate Spawner (excluding tolerant species); thus, creek chub and white sucker are left blank even though they are mineral-substrate spawners
Suckermouth minnow: Generalist feeder changed from "yes" to blank; Mineral-substrate spawner changed from blank to "yes"
Banded sculpin: Tolerance changed from blank to "yes"
-added column, "Native Benthic Invertivore"

Table 2. Illinois stream-fish species categorized by family, native status, trophic, reproductive, or tolerance group used to create metrics for revised Illinois IBIs. All categorizations apply to subadult and adult life stages of fish. "Specialist" refers to species that typically feed on two or fewer of the following four food types; "generalist" species feed on three or more food types: 1) detritus 2) algae or plants 3) invertebrates (excluding adult crayfish) 4) adult crayfish, vertebrates, or fish fluids (some lampreys). "Invertivore" refers to species that feed primarily on type-3 foods. "Benthic" species are those that feed primarily on foods associated with the stream bottom and that have adaptations for doing so (e.g., protrusile lips in suckers). "Mineral-substrate spawners" are species that require relatively silt-free, mineral substrates (e.g., clean sand to boulder) for deposition and successful development of eggs. "Mineral-substrate spawners" in this table exclude species whose Tolerance = "tolerant". Species categorized as BINV, SBI, GEN, or LIT0T are indicated with a "yes".

Common Name	Scientific Name	Family	Native Status	Native Benthic Invertivore	Specialist, Benthic Invertivore (SBI)	Generalist Feeder (GEN)	Mineral-substrate Spawner, excluding tolerants (LIT0T)	Tolerance
sea lamprey	*Petromyzon marinus*	Petromyzontidae	non-native		--	--	yes	–
silver lamprey	*Ichthyomyzon unicuspis*	Petromyzontidae	--		--	--	yes	–
northern brook lamprey	*Ichthyomyzon fossor*	Petromyzontidae	--		--	--	yes	intolerant
chestnut lamprey	*Ichthyomyzon castaneus*	Petromyzontidae	--		--	--	yes	–
American brook lamprey	*Lampetra appendix*	Petromyzontidae	--		--	--	yes	intolerant
least brook lamprey	*Lampetra aepyptera*	Petromyzontidae	--		--	--	yes	intolerant
lake sturgeon	*Acipenser fulvescens*	Acipenseridae	--	yes	yes	--	yes	–
shovelnose sturgeon	*Scaphirhynchus platorynchus*	Acipenseridae	--	yes	yes	--	yes	–
pallid sturgeon	*Scaphirhynchus albus*	Acipenseridae	--	yes	--	--	yes	intolerant
paddlefish	*Polyodon spathula*	Polyodontidae	--		--	--	yes	–
alligator gar	*Atractosteus spatula*	Lepisosteidae	--		--	--	--	–
shortnose gar	*Lepisosteus platostomus*	Lepisosteidae	--		--	--	--	–
longnose gar	*Lepisosteus osseus*	Lepisosteidae	--		--	--	--	–
spotted gar	*Lepisosteus oculatus*	Lepisosteidae	--		--	--	--	–
bowfin	*Amia calva*	Amiidae	--		--	--	--	–
American eel	*Anguilla rostrata*	Anguillidae	--		--	--	--	–
alewife	*Alosa pseudoharengus*	Clupeidae	non-native		--	--	--	–
skipjack herring	*Alosa chrysochloris*	Clupeidae	--		--	--	--	–
Alabama shad	*Alosa alabamae*	Clupeidae	--		--	--	--	–
gizzard shad	*Dorosoma cepedianum*	Clupeidae	--		--	yes	--	–
threadfin shad	*Dorosoma petenense*	Clupeidae	non-native		--	yes	--	–
goldeye	*Hiodon alosoides*	Hiodontidae	--		--	--	--	–
mooneye	*Hiodon tergisus*	Hiodontidae	--		--	--	--	–
brook trout	*Salvelinus fontinalis*	Salmonidae	--		--	--	yes	intolerant
brown trout	*Salmo trutta*	Salmonidae	non-native		--	--	yes	–
rainbow trout	*Oncorhynchus mykiss*	Salmonidae	non-native		--	--	yes	–
rainbow smelt	*Osmerus mordax*	Osmeridae	non-native		--	--	--	–
central mudminnow	*Umbra limi*	Umbridae	--		--	--	--	–
grass pickerel	*Esox americanus*	Esocidae	--		--	--	--	–
northern pike	*Esox lucius*	Esocidae	--		--	--	--	–
muskellunge	*Esox masquinongy*	Esocidae	--		--	--	--	–

(Table 2. continued)

Common Name	Scientific Name	Family	Native Status	Native Benthic Invertivore	Specialist, Benthic Invertivore (SBI)	Generalist Feeder (GEN)	Mineral-substrate Spawner (LIT0T)	Tolerance
grass carp	*Ctenopharyngodon idella*	Cyprinidae	non-native		--	yes	--	–
bighead carp	*Hypophthalmichthys nobilis*	Cyprinidae	non-native		--	yes	--	–
silver carp	*Hypophthalmichthys molitrix*	Cyprinidae	non-native		--	yes	--	–
goldfish	*Carassius auratus*	Cyprinidae	non-native		--	yes	--	tolerant
common carp	*Cyprinus carpio*	Cyprinidae	non-native		--	yes	--	tolerant
rudd	*Scardinius erythrophthalmus*	Cyprinidae	non-native		--	yes	--	tolerant
golden shiner	*Notemigonus crysoleucas*	Cyprinidae	--		--	yes	--	tolerant
southern redbelly dace	*Phoxinus erythrogaster*	Cyprinidae	--		--	yes	yes	intolerant
creek chub	*Semotilus atromaculatus*	Cyprinidae	--		--	yes	--	tolerant
lake chub	*Couesius plumbeus*	Cyprinidae	--		--	--	--	–
hornyhead chub	*Nocomis biguttatus*	Cyprinidae	--		--	--	yes	intolerant
river chub	*Nocomis micropogon*	Cyprinidae	--		--	--	yes	intolerant
central stoneroller	*Campostoma anomalum*	Cyprinidae	--		--	--	yes	–
largescale stoneroller	*Campostoma oligolepis*	Cyprinidae	--		--	--	yes	–
suckermouth minnow	*Phenacobius mirabilis*	Cyprinidae	--	yes	--	--	yes	–
blacknose dace	*Rhinichthys atratulus*	Cyprinidae	--		--	yes	yes	–
longnose dace	*Rhinichthys cataractae*	Cyprinidae	--		--	--	yes	–
flathead chub	*Platygobio gracilis*	Cyprinidae	--		--	--	--	–
sicklefin chub	*Macrhybopsis meeki*	Cyprinidae	--		--	--	--	–
sturgeon chub	*Macrhybopsis gelida*	Cyprinidae	--		--	--	--	–
silver chub	*Macrhybopsis storeriana*	Cyprinidae	--	yes	yes	--	--	intolerant
gravel chub	*Erimystax x-punctatus*	Cyprinidae	--	yes	--	--	yes	intolerant
speckled chub	*Macrhybopsis aestivalis*	Cyprinidae	--	yes	yes	--	--	intolerant
Mississippi silvery minnow	*Hybognathus nuchalis*	Cyprinidae	--		--	--	--	–
western silvery minnow	*Hybognathus argyritis*	Cyprinidae	--		--	--	--	–
plains minnow	*Hybognathus placitus*	Cyprinidae	--		--	--	--	–
brassy minnow	*Hybognathus hankinsoni*	Cyprinidae	--		--	yes	--	–
cypress minnow	*Hybognathus hayi*	Cyprinidae	--		--	--	--	intolerant
striped shiner	*Luxilus chrysocephalus*	Cyprinidae	--		--	yes	yes	–
common shiner	*Luxilus cornutus*	Cyprinidae	--		--	yes	yes	–
redfin shiner	*Lythrurus umbratilis*	Cyprinidae	--		--	yes	yes	–
rosefin shiner	*Lythrurus ardens*	Cyprinidae	--		--	yes	yes	–
ribbon shiner	*Lythrurus fumeus*	Cyprinidae	--		--	yes	--	–
bluehead shiner	*Pteronotropis hubbsi*	Cyprinidae	--		--	--	--	–
spotfin shiner	*Cyprinella spiloptera*	Cyprinidae	--		--	yes	--	–
steelcolor shiner	*Cyprinella whipplei*	Cyprinidae	--		--	--	--	–
blacktail shiner	*Cyprinella venusta*	Cyprinidae	--		--	--	--	–
red shiner	*Cyprinella lutrensis*	Cyprinidae	--		--	yes	--	tolerant
pugnose minnow	*Opsopoeodus emiliae*	Cyprinidae	--		--	yes	--	intolerant
fathead minnow	*Pimephales promelas*	Cyprinidae	--		--	yes	--	tolerant
bluntnose minnow	*Pimephales notatus*	Cyprinidae	--		--	yes	--	tolerant
bullhead minnow	*Pimephales vigilax*	Cyprinidae	--		--	yes	--	–
pugnose shiner	*Notropis anogenus*	Cyprinidae	--		--	yes	--	intolerant
emerald shiner	*Notropis atherinoides*	Cyprinidae	--		--	--	--	–
river shiner	*Notropis blennius*	Cyprinidae	--		--	--	--	–
bigeye shiner	*Notropis boops*	Cyprinidae	--		--	--	--	intolerant
ghost shiner	*Notropis buchanani*	Cyprinidae	--		--	--	--	–
silverjaw minnow	*Notropis buccatus*	Cyprinidae	--		--	yes	--	–

(Table 2. continued)

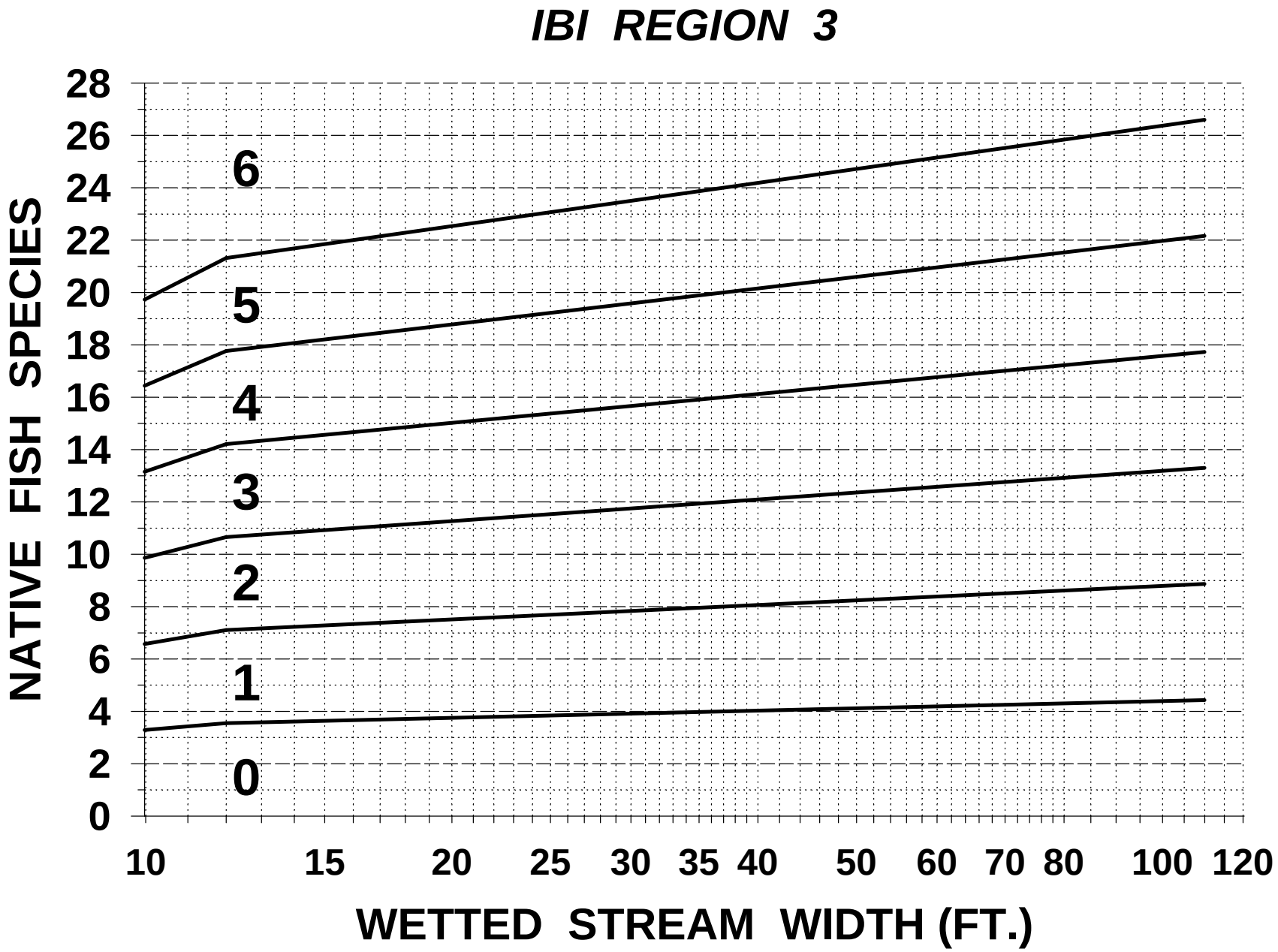
Common Name	Scientific Name	Family	Native Status	Native Benthic Invertivore	Specialist, Benthic Invertivore (SBI)	Generalist Feeder (GEN)	Mineral-substrate Spawner (LIT0T)	Tolerance
ironcolor shiner	*Notropis chalybaeus*	Cyprinidae	--		--	--	yes	intolerant
bigmouth shiner	*Notropis dorsalis*	Cyprinidae	--	yes	--	yes	--	–
blackchin shiner	*Notropis heterodon*	Cyprinidae	--		--	--	--	intolerant
blacknose shiner	*Notropis heterolepis*	Cyprinidae	--		--	--	--	intolerant
spottail shiner	*Notropis hudsonius*	Cyprinidae	--		--	yes	--	–
sand shiner	*Notropis stramineus*	Cyprinidae	--		--	yes	--	–
Ozark minnow	*Notropis nubilus*	Cyprinidae	--		--	--	--	intolerant
rosyface shiner	*Notropis rubellus*	Cyprinidae	--		--	--	yes	intolerant
silverband shiner	*Notropis shumardi*	Cyprinidae	--		--	--	--	–
taillight shiner	*Notropis maculatus*	Cyprinidae	--		--	--	--	intolerant
weed shiner	*Notropis texanus*	Cyprinidae	--		--	yes	--	intolerant
mimic shiner	*Notropis volucellus*	Cyprinidae	--		--	yes	--	–
channel shiner	*Notropis wickliffi*	Cyprinidae	--		--	--	--	--
bigeye chub	*Hybopsis amblops*	Cyprinidae	--	yes	yes	--	--	intolerant
pallid shiner	*Hybopsis amnis*	Cyprinidae	--		--	--	--	intolerant
bigmouth buffalo	*Ictiobus cyprinellus*	Catostomidae	--		--	yes	--	–
smallmouth buffalo	*Ictiobus bubalus*	Catostomidae	--	yes	--	yes	--	–
black buffalo	*Ictiobus niger*	Catostomidae	--	yes	--	yes	--	–
quillback	*Carpiodes cyprinus*	Catostomidae	--		--	yes	--	–
river carpsucker	*Carpiodes carpio*	Catostomidae	--		--	yes	--	–
highfin carpsucker	*Carpiodes velifer*	Catostomidae	--		--	yes	--	intolerant
blue sucker	*Cycleptus elongatus*	Catostomidae	--	yes	yes	--	yes	intolerant
white sucker	*Catostomus commersoni*	Catostomidae	--		--	yes	--	tolerant
longnose sucker	*Catostomus catostomus*	Catostomidae	--	yes	yes	--	yes	–
spotted sucker	*Minytrema melanops*	Catostomidae	--	yes	--	yes	yes	intolerant
creek chubsucker	*Erimyzon oblongus*	Catostomidae	--		--	yes	yes	–
lake chubsucker	*Erimyzon sucetta*	Catostomidae	--		--	yes	--	–
northern hog sucker	*Hypentelium nigricans*	Catostomidae	--	yes	yes	--	yes	intolerant
greater redhorse	*Moxostoma valenciennesi*	Catostomidae	--	yes	yes	--	yes	intolerant
river redhorse	*Moxostoma carinatum*	Catostomidae	--	yes	yes	--	yes	–
shorthead redhorse	*Moxostoma macrolepidotum*	Catostomidae	--	yes	yes	--	yes	–
black redhorse	*Moxostoma duquesnei*	Catostomidae	--	yes	yes	--	yes	intolerant
golden redhorse	*Moxostoma erythrurum*	Catostomidae	--	yes	yes	--	yes	–
silver redhorse	*Moxostoma anisurum*	Catostomidae	--	yes	yes	--	yes	–
channel catfish	*Ictalurus punctatus*	Ictaluridae	--		--	yes	--	–
blue catfish	*Ictalurus furcatus*	Ictaluridae	--		--	--	--	–
white catfish	*Ameiurus catus*	Ictaluridae	non-native		--	yes	--	–
yellow bullhead	*Ameiurus natalis*	Ictaluridae	--		--	yes	--	tolerant
black bullhead	*Ameiurus melas*	Ictaluridae	--		--	yes	--	–
brown bullhead	*Ameiurus nebulosus*	Ictaluridae	--		--	yes	--	–
flathead catfish	*Pylodictis olivaris*	Ictaluridae	--		--	--	--	–
stonecat	*Noturus flavus*	Ictaluridae	--	yes	--	--	--	–
tadpole madtom	*Noturus gyrinus*	Ictaluridae	--	yes	yes	--	--	–
freckled madtom	*Noturus nocturnus*	Ictaluridae	--	yes	yes	--	--	–
slender madtom	*Noturus exilis*	Ictaluridae	--	yes	yes	--	--	intolerant
northern madtom	*Noturus stigmosus*	Ictaluridae	--	yes	yes	--	--	intolerant
mountain madtom	*Noturus eleutherus*	Ictaluridae	--	yes	yes	--	--	intolerant
brindled madtom	*Noturus miurus*	Ictaluridae	--	yes	yes	--	--	intolerant

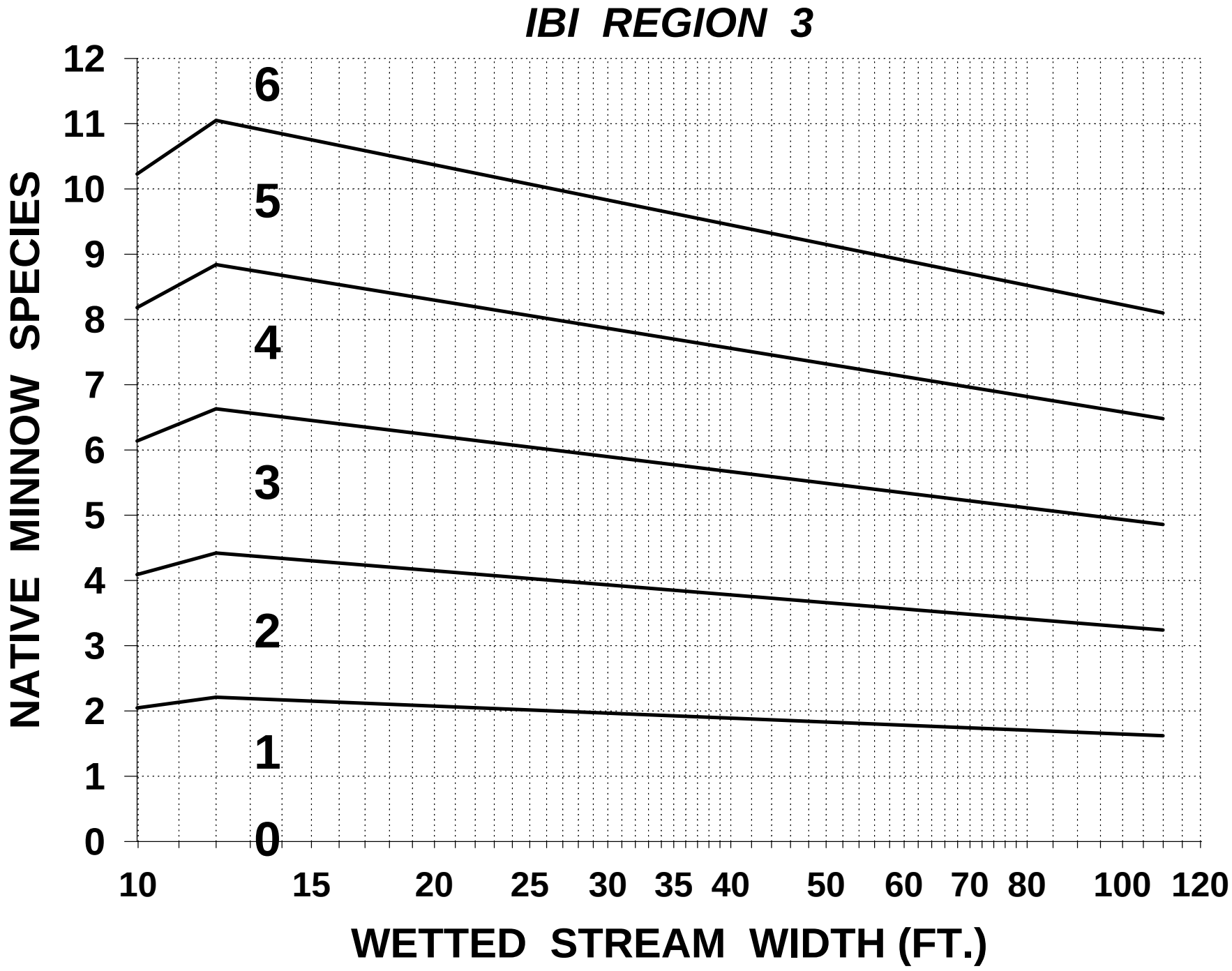
(Table 2. continued)

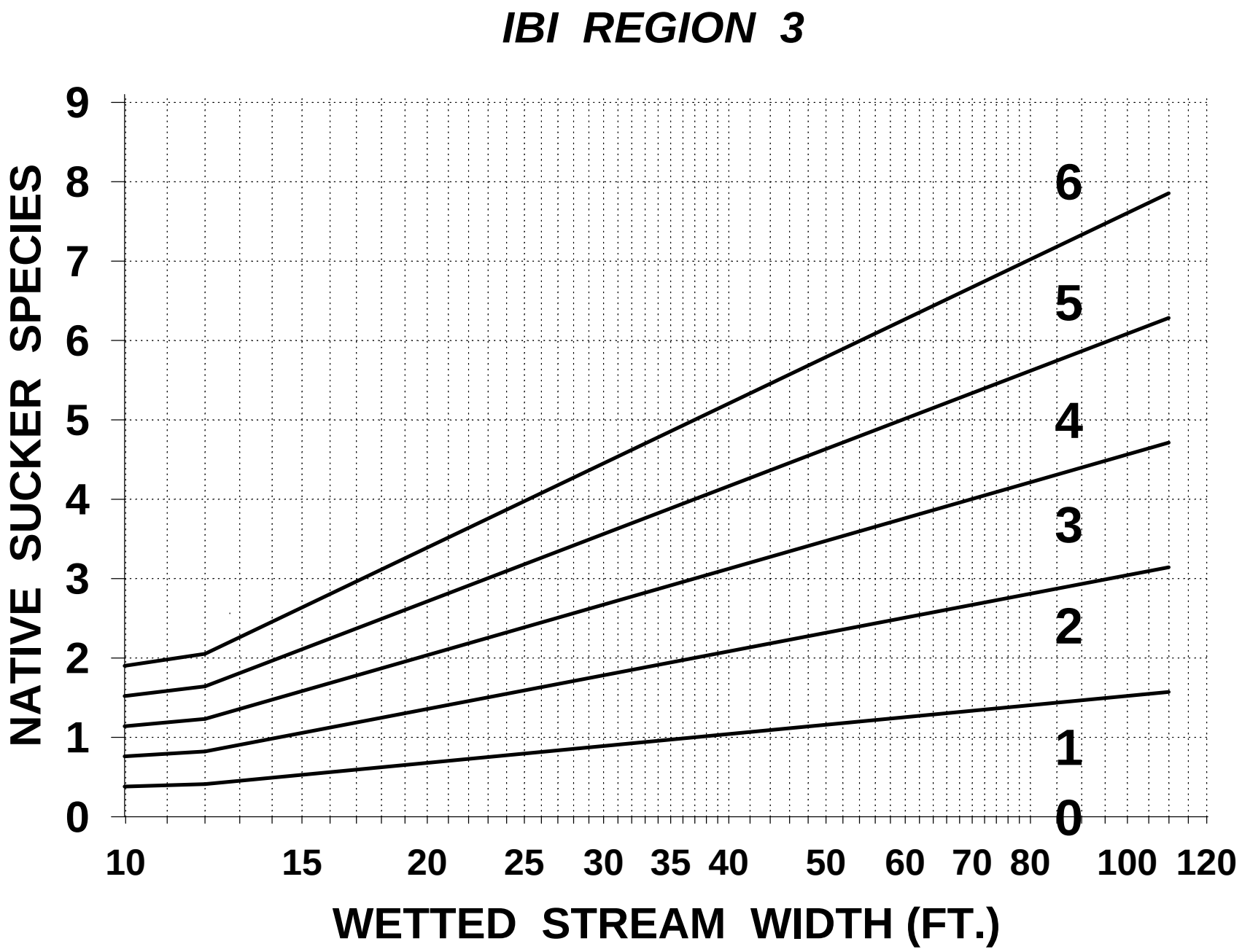
Common Name	Scientific Name	Family	Native Status	Native Benthic Invertivore	Specialist, Benthic Invertivore (SBI)	Generalist Feeder (GEN)	Mineral-substrate Spawner (LIT0T)	Tolerance
trout-perch	*Percopsis omiscomaycus*	Percopsidae	--	yes	yes	--	--	–
pirate perch	*Aphredoderus sayanus*	Aphredoderidae	--		--	--	--	–
spring cavefish	*Forbesella agassizi*	Amblyopsidae	--		--	--	--	–
burbot	*Lota lota*	Gadidae	--		--	--	yes	–
banded killifish	*Fundulus diaphanus*	Fundulidae	--		--	--	--	–
northern studfish	*Fundulus catenatus*	Fundulidae	--		--	--	yes	–
starhead topminnow	*Fundulus dispar*	Fundulidae	--		--	--	--	–
blackstripe topminnow	*Fundulus notatus*	Fundulidae	--		--	--	--	–
blackspotted topminnow	*Fundulus olivaceus*	Fundulidae	--		--	--	--	–
mosquitofish	*Gambusia affinis*	Poeciliidae	--		--	--	--	–
brook silverside	*Labidesthes sicculus*	Atherinidae	--		--	--	--	–
inland silverside	*Menidia beryllina*	Atherinidae	non-native		--	--	--	–
brook stickleback	*Culaea inconstans*	Gasterosteidae	--		--	--	--	–
ninespine stickleback	*Pungitius pungitius*	Gasterosteidae	--		--	--	--	–
threespine stickleback	*Gasterosteus aculeatus*	Gasterosteidae	non-native		--	--	--	–
banded sculpin	*Cottus carolinae*	Cottidae	--	yes	yes	--	--	intolerant
mottled sculpin	*Cottus bairdi*	Cottidae	--	yes	yes	--	--	intolerant
striped bass	*Morone saxatilis*	Moronidae	non-native		--	--	--	–
white bass	*Morone chrysops*	Moronidae	--		--	--	--	–
yellow bass	*Morone mississippiensis*	Moronidae	--		--	--	--	–
white perch	*Morone americana*	Moronidae	non-native		--	--	--	–
banded pygmy sunfish	*Elassoma zonatum*	Centrarchidae	--		--	--	--	–
flier	*Centrarchus macropterus*	Centrarchidae	--		--	--	--	–
black crappie	*Pomoxis nigromaculatus*	Centrarchidae	--		--	--	--	–
white crappie	*Pomoxis annularis*	Centrarchidae	--		--	--	--	–
rock bass	*Ambloplites rupestris*	Centrarchidae	--		--	--	yes	–
largemouth bass	*Micropterus salmoides*	Centrarchidae	--		--	--	--	–
spotted bass	*Micropterus punctulatus*	Centrarchidae	--		--	--	--	–
smallmouth bass	*Micropterus dolomieu*	Centrarchidae	--		--	--	yes	intolerant
warmouth	*Lepomis gulosus*	Centrarchidae	--		--	--	--	–
green sunfish	*Lepomis cyanellus*	Centrarchidae	--		--	yes	--	tolerant
bantam sunfish	*Lepomis symmetricus*	Centrarchidae	--		--	--	--	–
spotted sunfish	*Lepomis punctatus*	Centrarchidae	--		--	--	--	–
bluegill	*Lepomis macrochirus*	Centrarchidae	--		--	yes	--	–
redear sunfish	*Lepomis microlophus*	Centrarchidae	--		--	--	--	–
pumpkinseed	*Lepomis gibbosus*	Centrarchidae	--		--	--	--	–
longear sunfish	*Lepomis megalotis*	Centrarchidae	--		--	--	--	–
orangespotted sunfish	*Lepomis humilis*	Centrarchidae	--		--	--	--	–

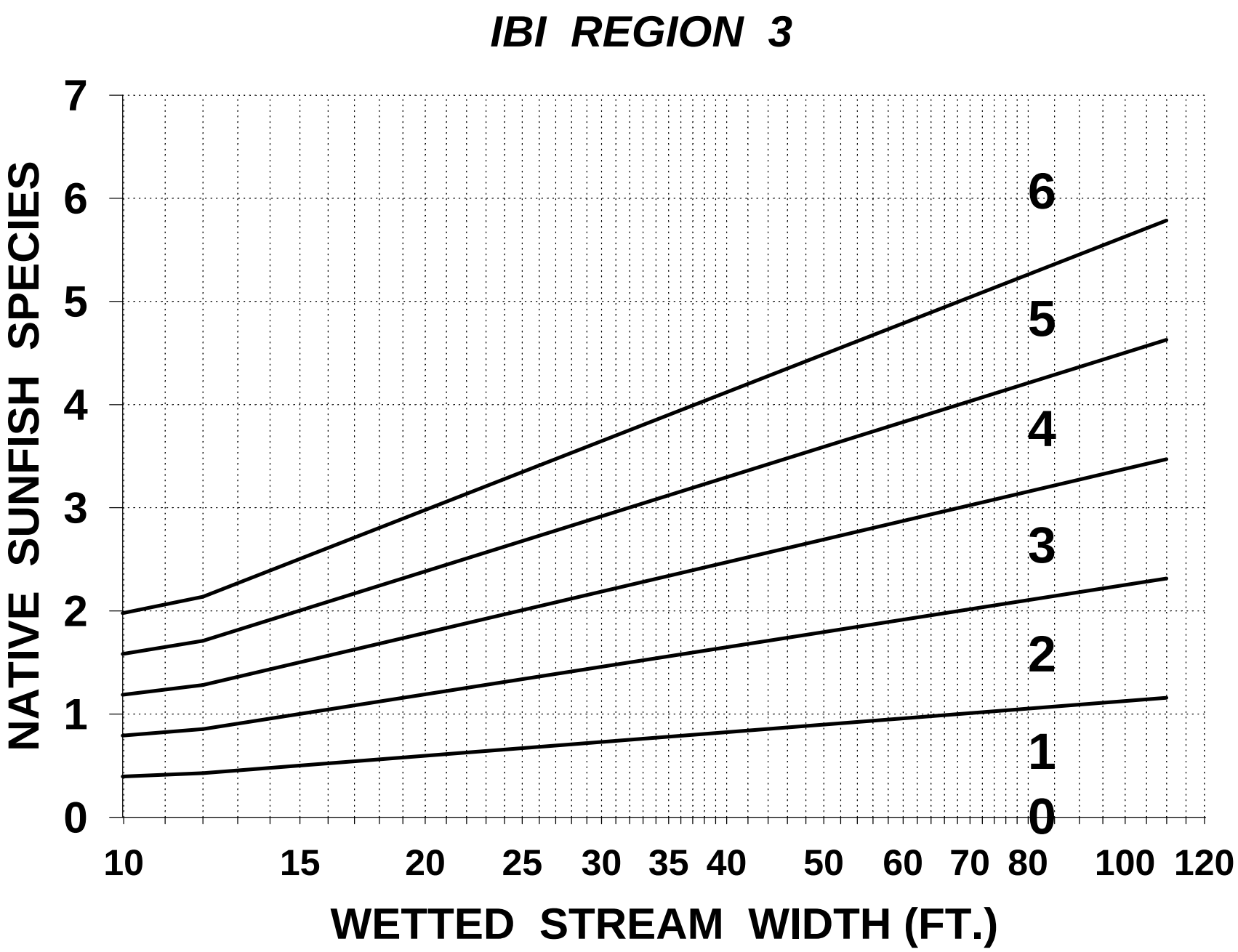
(Table 2. continued)

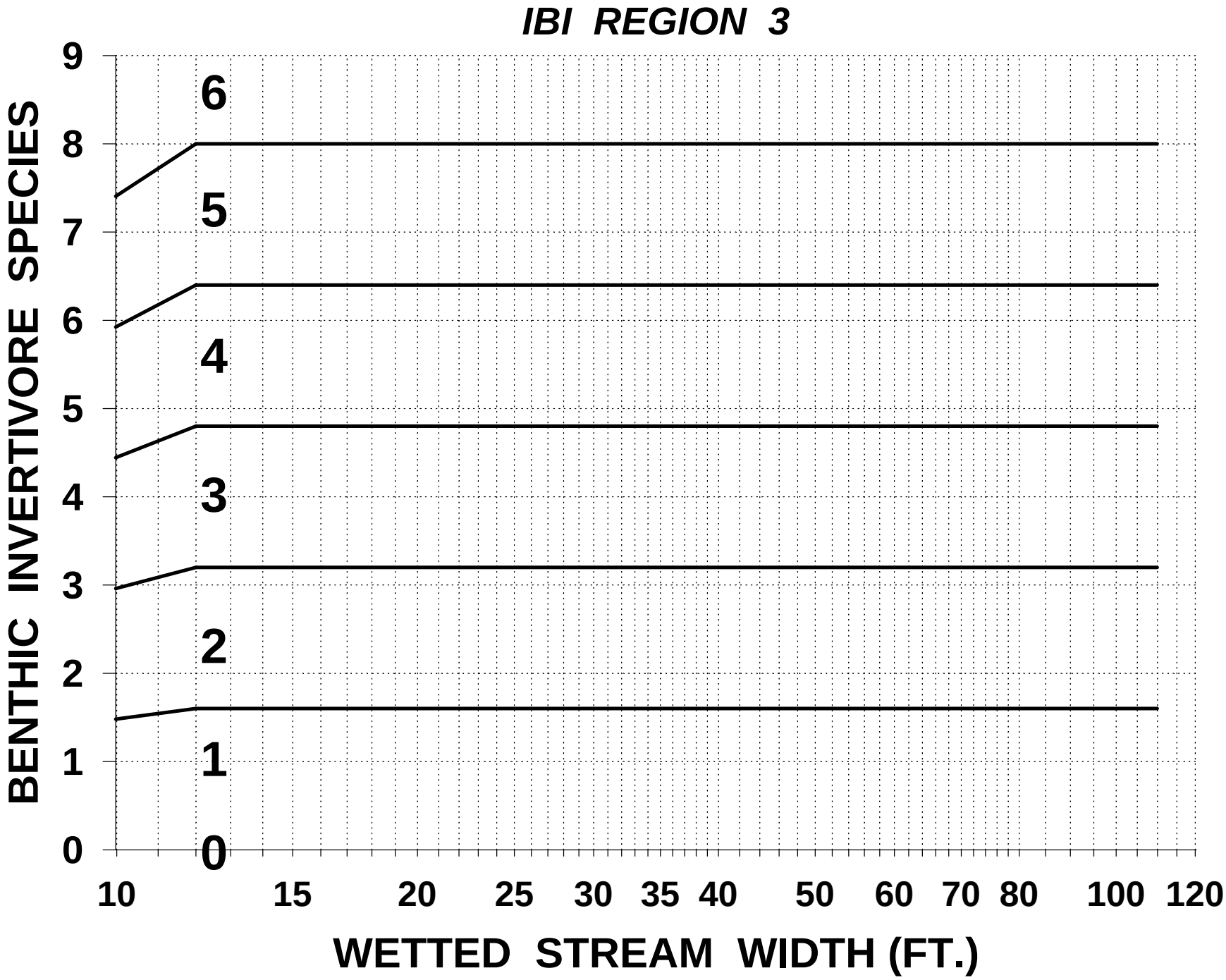
Common Name	Scientific Name	Family	Native Status	Native Benthic Invertivore	Specialist, Benthic Invertivore (SBI)	Generalist Feeder (GEN)	Mineral-substrate Spawner (LIT0T)	Tolerance
walleye	*Stizostedion vitreum*	Percidae	--		--	--	yes	–
sauger	*Stizostedion canadense*	Percidae	--		--	--	yes	–
yellow perch	*Perca flavescens*	Percidae	--		--	--	--	–
blackside darter	*Percina maculata*	Percidae	--	yes	yes	--	yes	–
dusky darter	*Percina sciera*	Percidae	--	yes	yes	--	yes	–
river darter	*Percina shumardi*	Percidae	--	yes	yes	--	yes	–
stargazer darter	*Percina uranidea*	Percidae	--	yes	yes	--	yes	–
gilt darter	*Percina evides*	Percidae	--	yes	yes	--	yes	intolerant
slenderhead darter	*Percina phoxocephala*	Percidae	--	yes	yes	--	yes	intolerant
logperch	*Percina caprodes*	Percidae	--	yes	yes	--	yes	–
crystal darter	*Ammocrypta asprella*	Percidae	--	yes	yes	--	yes	intolerant
western sand darter	*Ammocrypta clara*	Percidae	--	yes	yes	--	yes	intolerant
eastern sand darter	*Ammocrypta pellucida*	Percidae	--	yes	yes	--	yes	intolerant
johnny darter	*Etheostoma nigrum*	Percidae	--	yes	yes	--	--	–
bluntnose darter	*Etheostoma chlorosomum*	Percidae	--	yes	yes	--	--	–
greenside darter	*Etheostoma blennioides*	Percidae	--	yes	yes	--	--	–
harlequin darter	*Etheostoma histrio*	Percidae	--	yes	yes	--	--	intolerant
banded darter	*Etheostoma zonale*	Percidae	--	yes	yes	--	--	intolerant
bluebreast darter	*Etheostoma camurum*	Percidae	--	yes	yes	--	yes	intolerant
rainbow darter	*Etheostoma caeruleum*	Percidae	--	yes	yes	--	yes	intolerant
mud darter	*Etheostoma asprigene*	Percidae	--	yes	yes	--	--	–
orangethroat darter	*Etheostoma spectabile*	Percidae	--	yes	yes	--	yes	–
spottail darter	*Etheostoma squamiceps*	Percidae	--	yes	yes	--	--	–
stripetail darter	*Etheostoma kennicotti*	Percidae	--	yes	yes	--	--	–
fantail darter	*Etheostoma flabellare*	Percidae	--	yes	yes	--	--	–
least darter	*Etheostoma microperca*	Percidae	--	yes	yes	--	--	–
cypress darter	*Etheostoma proeliare*	Percidae	--	yes	yes	--	--	–
slough darter	*Etheostoma gracile*	Percidae	--	yes	yes	--	--	–
Iowa darter	*Etheostoma exile*	Percidae	--	yes	yes	--	--	intolerant
fringed darter	*Etheostoma crossopterum*	Percidae	--	yes	yes	--	--	–
freshwater drum	*Aplodinotus grunniens*	Sciaenidae	--		--	--	--	–
round goby	*Neogobius melanostomus*	Gobiidae	non-native		--	--	--	–
oriental weatherfish	*Misgurnus anguillicaudatus*	Cobitidae	non-native		--	--	--	–

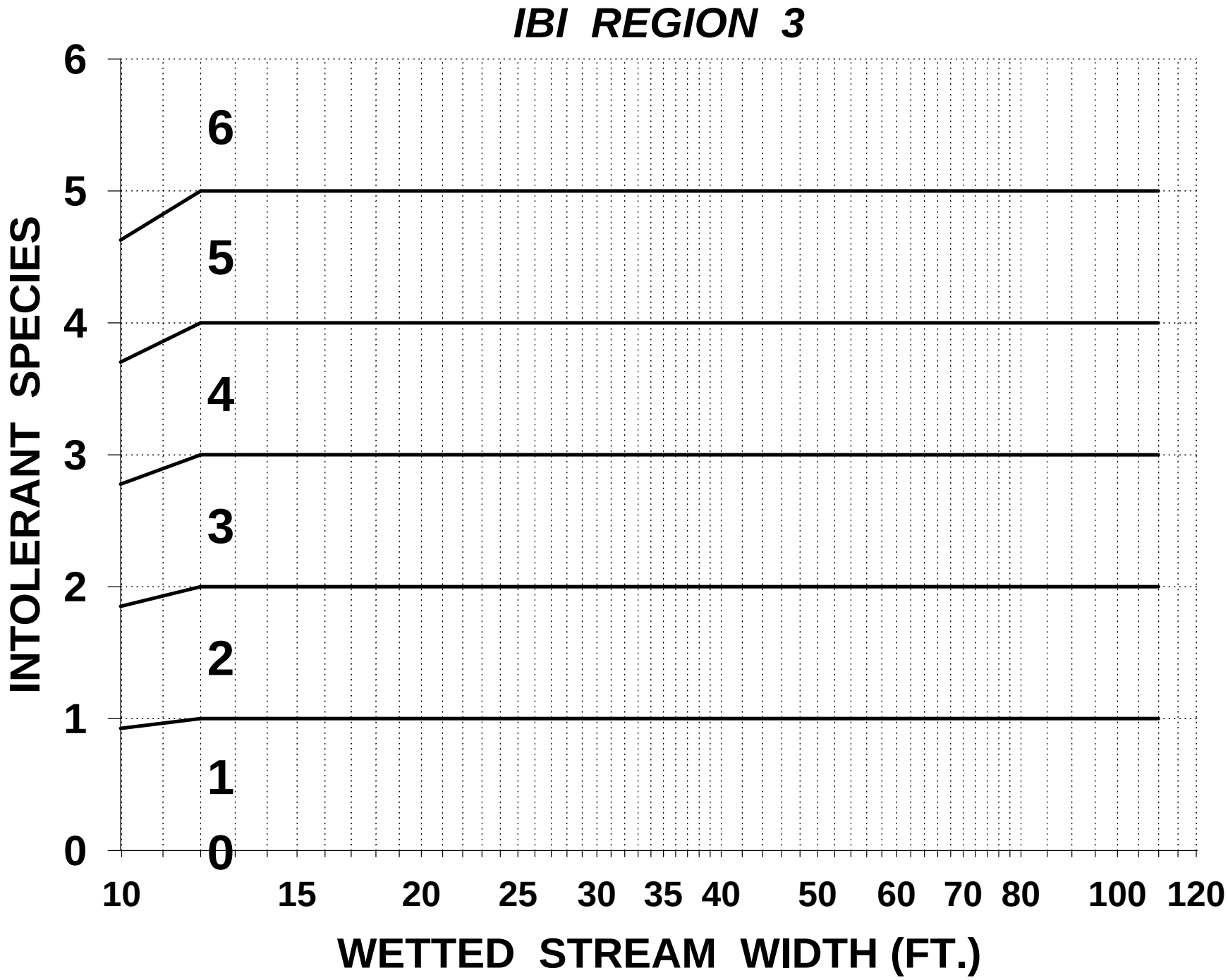

IBI REGION 3
NATIVE FISH SPECIES
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
6
5
4
3
2
1
0
10
15
20
25
30
35
40
50
60
70
80
100
120
WETTED STREAM WIDTH (FT.)

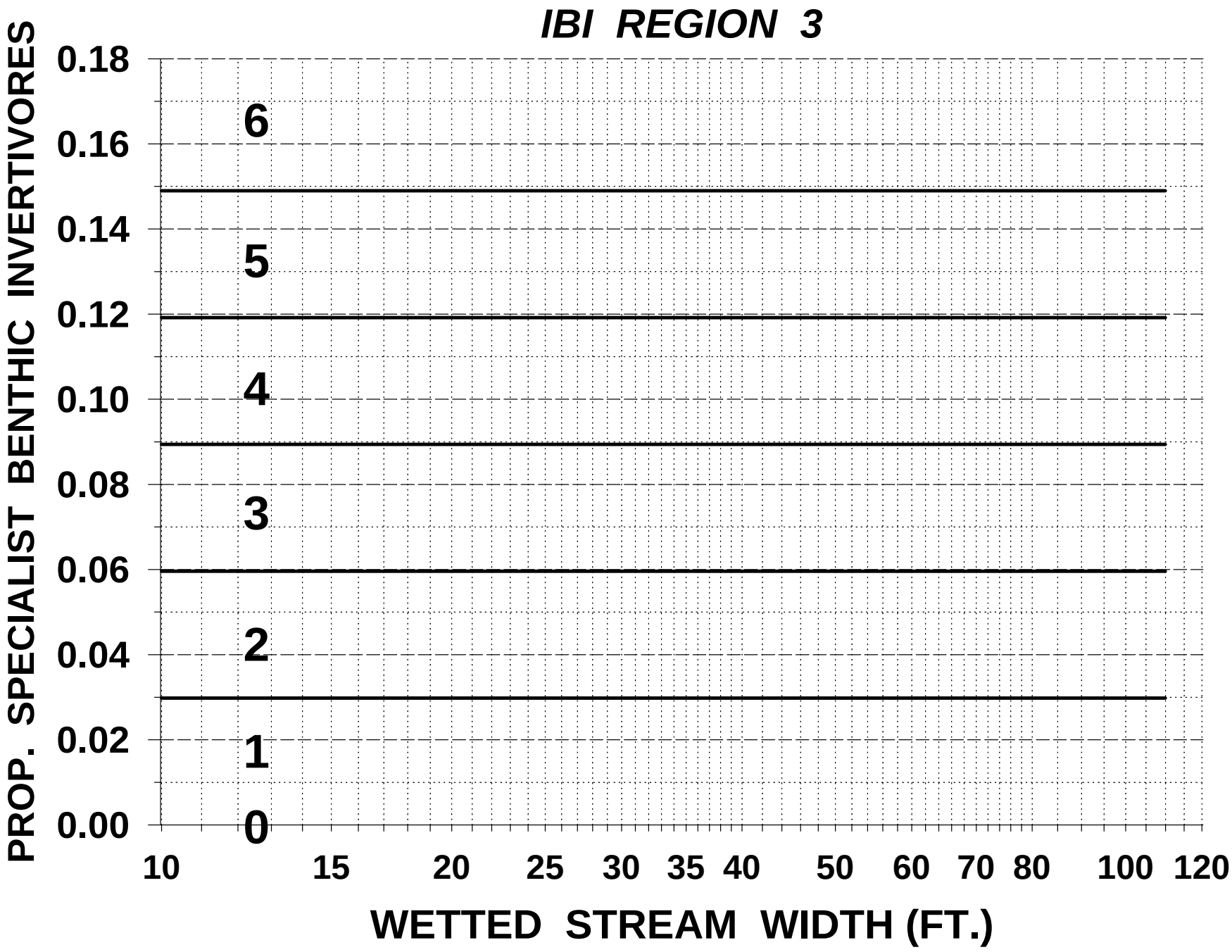

IBI REGION 3
NATIVE MINNOW SPECIES
WETTED STREAM WIDTH (FT.)
0
1
2
3
4
5
6
0 1 2 3 4 5 6 7 8 9 10 11 12
10 15 20 25 30 35 40 50 60 70 80 100 120

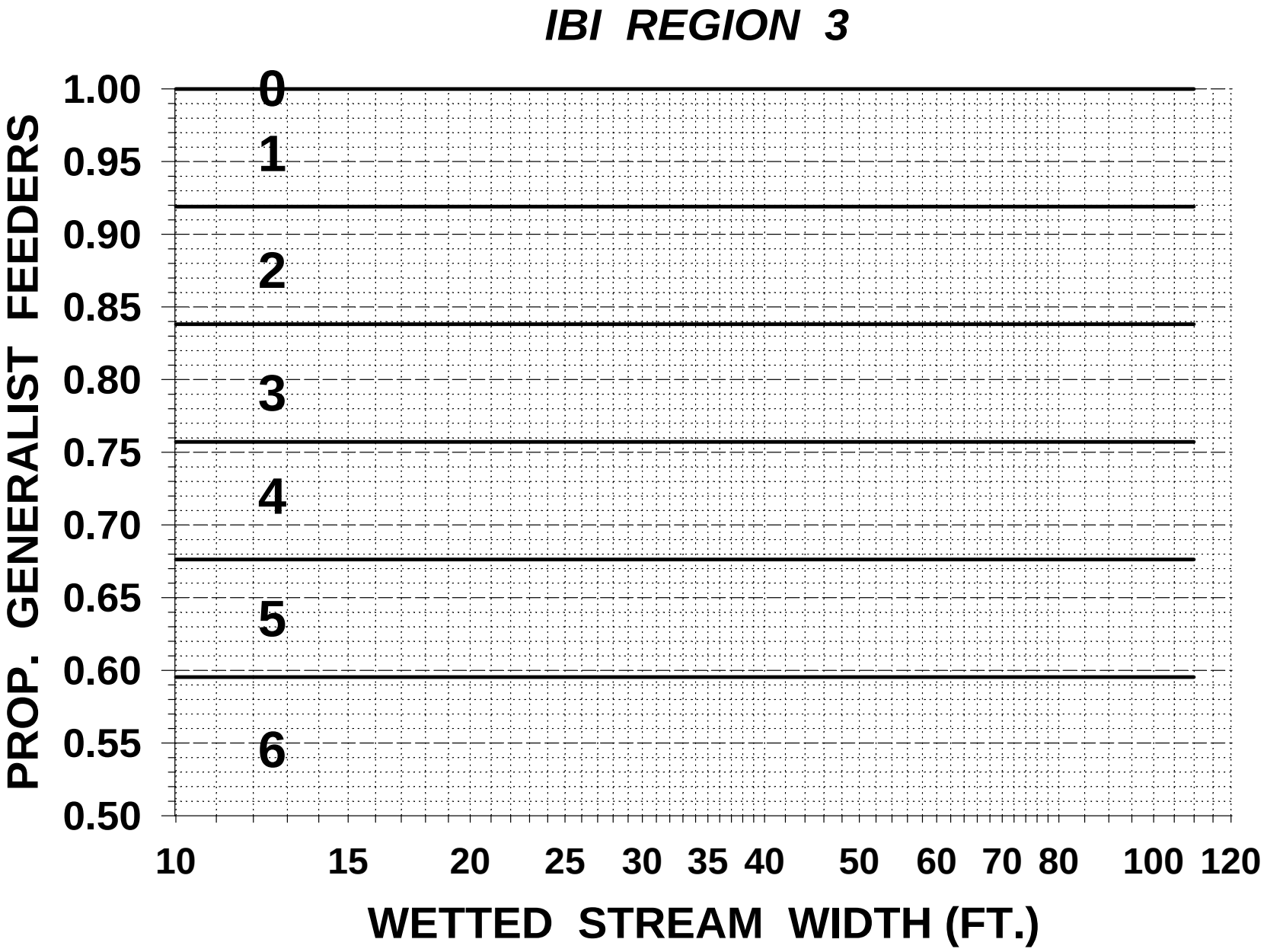

IBI REGION 3
NATIVE SUCKER SPECIES
0
1
2
3
4
5
6
7
8
9
10
15
20
25
30
35
40
50
60
70
80
100
120
WETTED STREAM WIDTH (FT.)
6
5
4
3
2
1
0

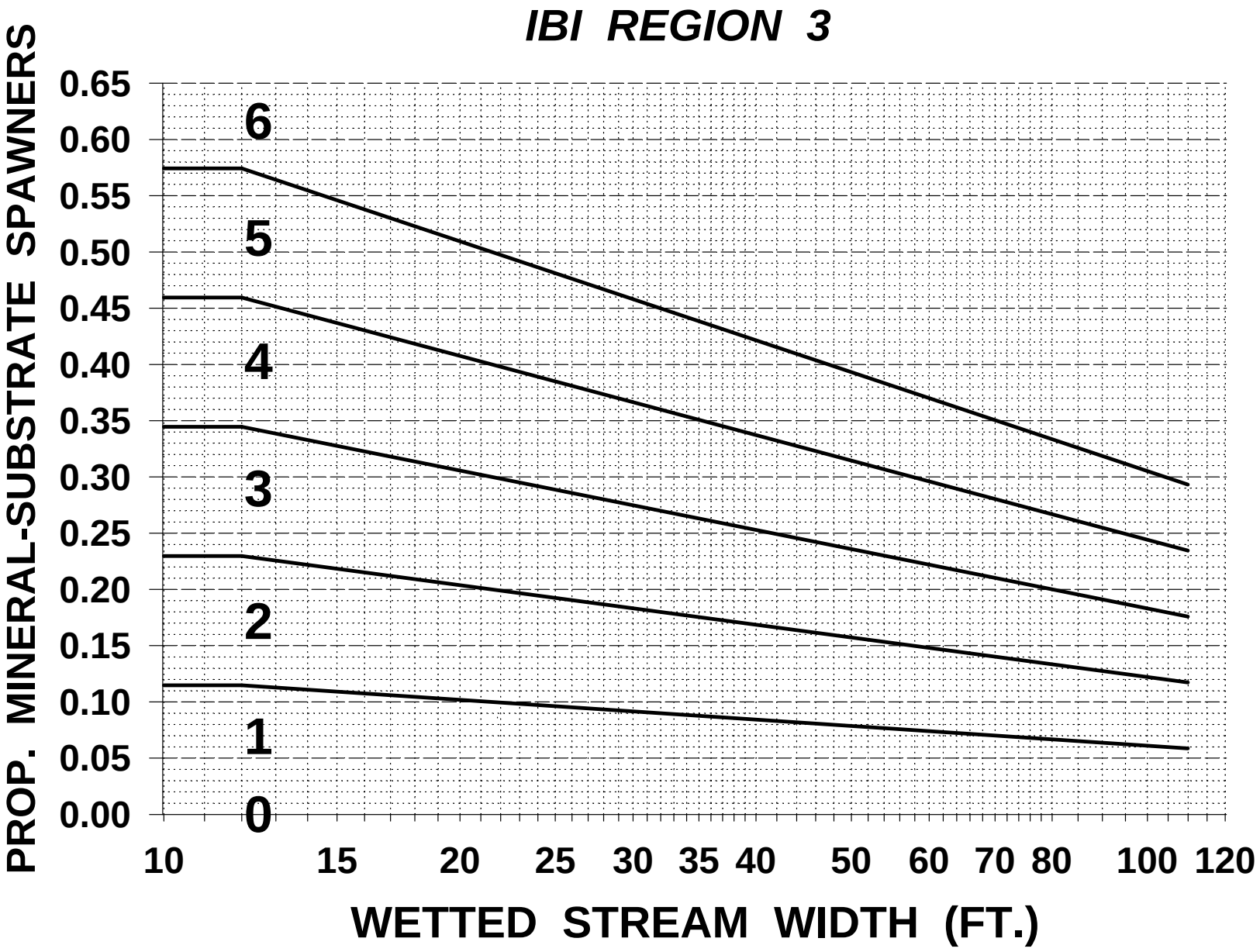

IBI REGION 3
NATIVE SUNFISH SPECIES
0
1
2
3
4
5
6
7
10
15
20
25
30
35
40
50
60
70
80
100
120
WETTED STREAM WIDTH (FT.)

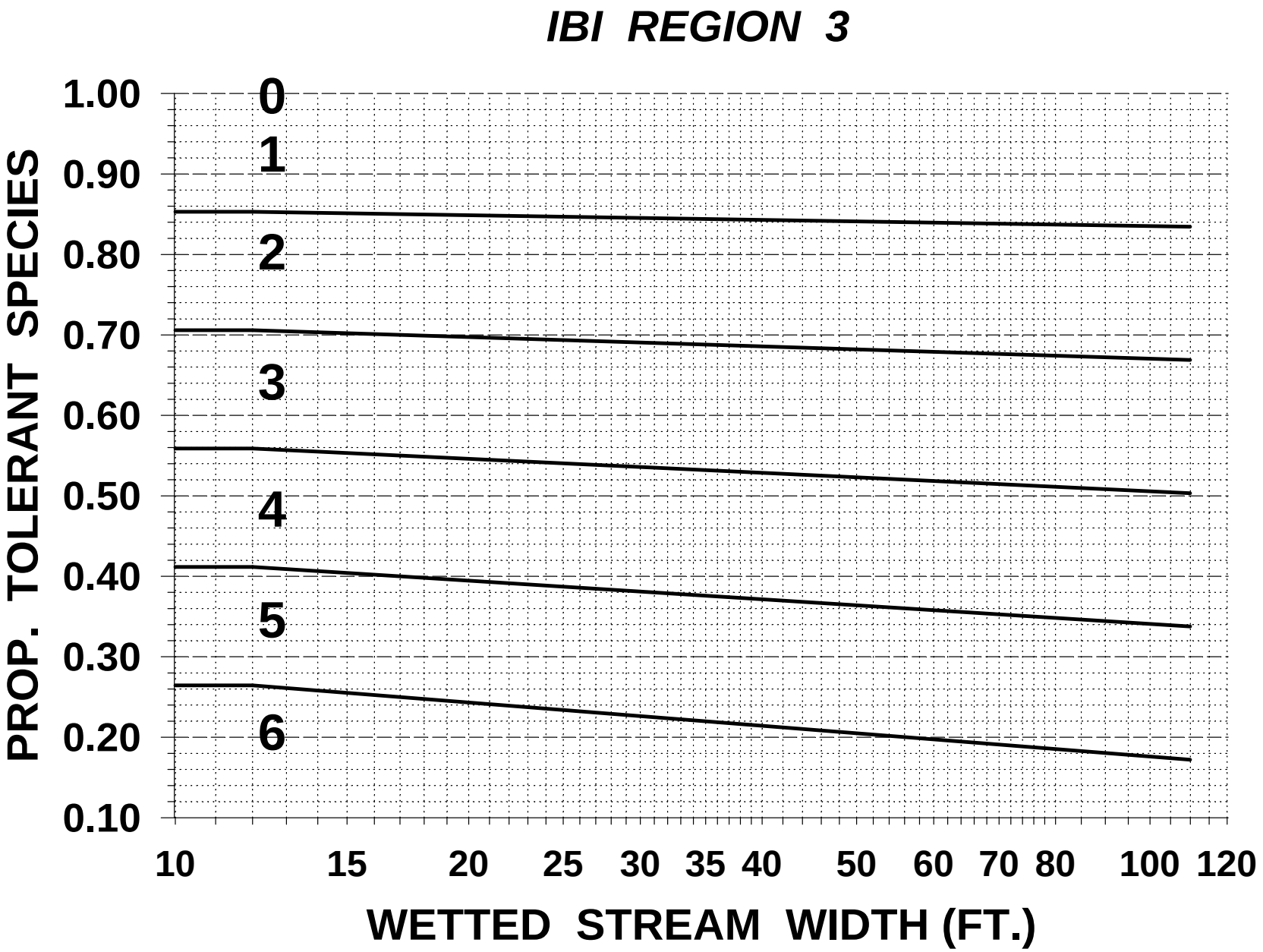

IBI REGION 3
BENTHIC INVERTIVORE SPECIES
0
1
2
3
4
5
6
7
8
9
10
15
20
25
30
35
40
50
60
70
80
100
120
WETTED STREAM WIDTH (FT.)


IBI REGION 3
INTOLERANT SPECIES
0
1
2
3
4
5
6
10
15
20
25
30
35
40
50
60
70
80
100
120
WETTED STREAM WIDTH (FT.)


IBI REGION 3
PROP. SPECIALIST BENTHIC INVERTIVORES
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
6
5
4
3
2
1
0
10
15
20
25
30
35
40
50
60
70
80
100
120
WETTED STREAM WIDTH (FT.)


IBI REGION 3
PROP. GENERALIST FEEDERS
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0
1
2
3
4
5
6
10
15
20
25
30
35
40
50
60
70
80
100
120
WETTED STREAM WIDTH (FT.)


IBI REGION 3
PROP. MINERAL-SUBSTRATE SPAWNERS
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
6
5
4
3
2
1
0
10
15
20
25
30
35
40
50
60
70
80
100
120
WETTED STREAM WIDTH (FT.)


IBI REGION 3
PROP. TOLERANT SPECIES
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0
1
2
3
4
5
6
10
15
20
25
30
35
40
50
60
70
80
100
120
WETTED STREAM WIDTH (FT.)